PRINCETON®

GRAPHIC SYSTEMS

ULTRASYNC SERIES SERVICE MANUAL

ULTRASYNC ULTRA 14 ULTRA 16

Princeton Graphic Systems
1125 Northmeadow Parkway
Suite 120
Roswell, Georgia 30076

11/91

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10.0 ULTRASYNC SERIES PARTS LIST

Foreword

Throughout this manual you will see warnings and precautions relating to the service of an **ULTRASYNC Series** monitor. Please read and observe all warnings, notes, and precautions. Dangerous voltage and current are present within the covers of this monitor. There may be residual voltages present in this unit, although it has not been used for some time. For your safety, please refer all service to qualified service personnel. Princeton Graphic Systems maintains a full staff of qualified technicians to provide prompt, authorized service. We strongly recommend that you send your monitor to Princeton Graphic Systems for authorized service.

Princeton Graphic Systems will not be held liable for any injury or damages caused by any internal adjustments, repairs, or modifications not performed by authorized Princeton Graphic Systems staff.

Your Princeton Graphic Systems **ULTRASYNC Series** color monitor is covered by a two (2) year parts and one (1) year labor warranty against all defects in material and workmanship. Should your monitor require service within this period, you should have the unit serviced by an authorized Princeton Graphic Systems service facility. Any unauthorized service will void your warranty. Your warranty will be void if any modification is made to this monitor. Please refer to your warranty card for complete information.

Should your monitor require service, or should you need technical assistance, please call our Technical Support Department or write:

PRINCETON GRAPHIC SYSTEMS
1125 Northmeadow Parkway - Suite 120
Roswell, GA 30076
ATTN: Technical Support
(404) 664-1010

Please supply a detailed description of the problem, the model and serial number of your unit, the make and model of your video display controller, the type of system you are using, and the circumstances of the problem. Princeton Graphic Systems' hours are between 8:30 am and 5:30 pm, Monday through Friday (Eastern Standard Time). **Before returning any monitor to Princeton Graphic Systems for service, you must get a Returned Material Authorization [RMA] number from Princeton Graphic Systems.**

EQUIPMENT RECEIVED WITHOUT AN AUTHORIZED RMA NUMBER PRINTED ON THE OUTSIDE OF THE BOX WILL NOT BE ACCEPTED AND WILL BE REJECTED AND RETURNED FREIGHT COLLECT.

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1.0 PURPOSE

This publication is for use of Princeton Graphics Systems employees, and authorized third party maintenance organizations. While this may be provided to other persons on request, the presentation of this document shall not be construed as permission to open the monitor and/or perform any internal adjustments, repairs, or modifications. Please read "Disclaimer" below:

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2.0 INTRODUCTION

OVERVIEW

The **ULTRASYNC** is an autosynchronous, high resolution color monitor designed to display both text and graphics. The monitor will display any mode between 640x480 up to 800x600 in infinite colors with a Video Graphics Adaptor (VGA) board in the analog position. When the monitor is in the TTL mode they will display any mode between 640x200 up to 640x350 with an IBM Color Graphics (CGA) and Enhanced Graphics (EGA) adapter.

The **ULTRA 14** and **ULTRA 16** are also autosyncronous, high resolution color monitors designed to display both text and graphics. These monitors will display any mode between 640x480 up to 1024x768 in infinite colors with a Video Graphics Adaptor (VGA) board or an IBM 8514/A adapter in the analog position. When these monitors are in the TTL mode they will display any mode between 640x200 up to 640x350 with an IBM Color Graphics (CGA) and Enhanced Graphics (EGA) adapters.

3.0 WARNING

The **ULTRASYNC Series** monitor, as well as all Princeton Graphic Systems products, is covered by a full two (2) year parts one (1) year labor warranty against any defects in materials or workmanship. Should your monitor fail to operate as specified within the stated warranty period from original retail purchase, you must return the monitor to Princeton Graphic Systems or an AUTHORIZED Princeton Graphic Systems service organization for proper repairs.

If, at any time, the monitor is opened by persons not authorized by Princeton Graphic Systems, the warranty for that product will be null and void. This monitor, as well as all other monitors, operates with high voltage and current levels. These voltages may continue to be present long after power has been disconnected from the monitor. Service should be performed only by experienced, qualified individuals. For your own protection, you should never service any electrical device without having someone present to provide aid in the event of an emergency.

4.0 EQUIPMENT REQUIREMENTS

In addition to the monitor, you will need the following:

* IBM or compatible PC, PC/XT, PC/AT with 256k RAM, 1 Disk Drive.
* PC-DOS or MS-DOS 2.10 or higher.
* IBM Enhanced Graphics Adapter(EGA) or IBM Video Graphics Adaptor (VGA).
* Phillips-head, 3/8 and 1/4 inch slotted screwdrivers.
* Non-metallic TV alignment tool kit.
* DC Volt meter
* High-Voltage probe for volt meter.
* Triggered Oscilloscope for 20MHz or higher Bandwidth
* AC Isolation Transformer with safety fuse
* Minolta TV-2130 Color Analyzer

5.0 IMPORTANT SERVICING SAFETY PRECAUTIONS

Only qualified, authorized persons should attempt any servicing of this monitor. Please be thoroughly familiar with all of the following safety checks and guidelines before removing the cover of the monitor.

5.1 WARNING

1. For continued safety and service, do not attempt to modify any circuit in this unit.
2. Disconnect AC power source before servicing unit.
3. The transistor heat sinks are potential shock hazards when power is applied to the monitor.

5.2 SERVICING OF HIGH VOLTAGE SYSTEM AND PICTURE TUBE

When attempting to service the high voltage system, remove the static charge from the Cathode Ray Tube (CRT) by using a 10k ohm resistor in series with an insulated wire (such as a test probe) to short the anode lead of the CRT to the chassis. The CRT uses integral implosion protection. Please follow safety precautions:

5.2 SERVICING OF HIGH VOLTAGE SYSTEM AND PICTURE TUBE *(continued)*

1. Discharge static high-voltage completely before handling CRT.
2. Wear shatter-proof safety goggles when handling the CRT.
3. Do not lift CRT by the neck.
4. Always replace the CRT with the same type and number.

5.3 X-RADIATION AND HIGH VOLTAGE LIMITS

1. X-Radiation is potentially dangerous and should be approached with extreme caution.
2. The only potential source of X-radiation is the CRT. If the high voltage is kept at the factory set levels, there are no measurable X-ray emissions from the CRT.
3. Only if the high voltage exceeds the factory set levels is the X-radiation capable of penetrating the shield of the lead-filled picture tube. Therefore, it is vital to maintain the high voltage at specified levels.
4. Operation at higher voltages could also cause failures in the CRT or high voltage circuitry.
5. When servicing a monitor with excessive high voltage, avoid being unnecessarily close to the monitor. Also, do not operate the monitor longer than necessary to locate the defect.
6. Every time a monitor chassis is serviced, the brightness should be adjusted while the high voltage is being monitored with a meter. This is necessary to assure that the high voltage is not excessive and that the regulators are operating properly.
7. An accurate high voltage meter should be available at all times.
8. Replace the CRT only with the type and model specified and do not make non-recommended circuit modifications.

5.4 SAFETY NOTICE

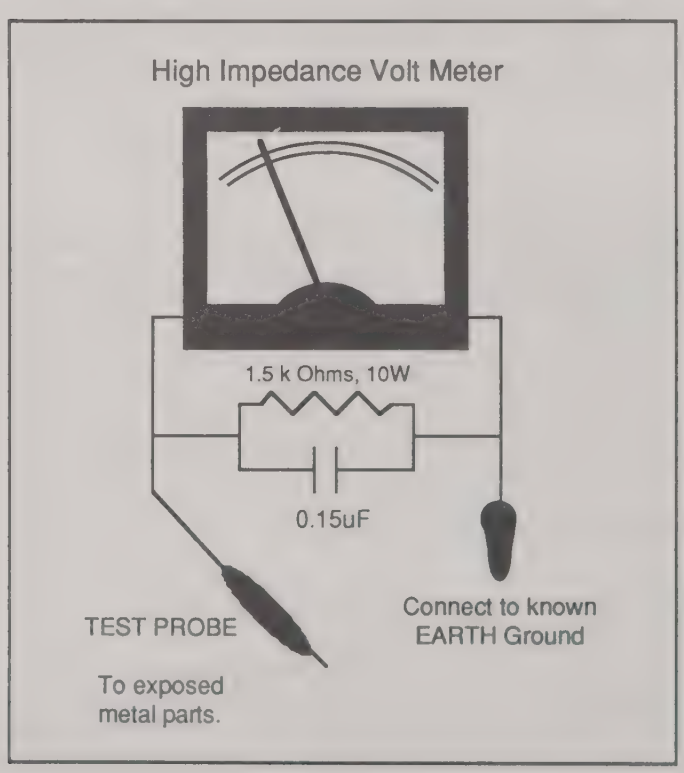
Many electrical and mechanical parts in this monitor have special safety related characteristics. These characteristics are often not evident from visual inspection, nor can the protection afforded by them be necessarily increased by using components rated for high voltage, power, etc. Parts which have these special safety characteristics are identified in the parts list at the end of this manual. Please refer to this list before replacing any parts. For continued protection, replacement parts must be identical to those used in the original circuit. The use of a substitute part which does not have the same safety characteristics as the part specified in this service manual may create shock, fire, X-radiation, or other hazards.

5.5 FIRE AND SHOCK HAZARD

Perform the following checks before returning the unit to the customer:

1. Assure that no hardware is lodged between the chassis and any metal parts in the monitor.
2. Check to see that no insulation or dressing is pinched, cracked or otherwise faulty.
3. Check all the non-metallic protective devices such as control knobs, cabinet backs, insulating fishpapers, etc.
4. To insure against shock hazards, check for leakage current in the following manner:

* Plug monitor AC cord directly into AC outlet. Do not use an isolation transformer for this test.
* Connect one end each of two clip leads to a 1.5k Ohm , 10W resistor paralleled by a 0.15uF capacitor (see drawing below).
* Connect an AC voltmeter with 1k Ohm per volt (or higher) sensitivity across the resistor.
* Connect one clip lead to a known ground (such as a water pipe). Use the other lead to check all exposed metal parts (ie., screws, screw posts, knob posts, signal connector, etc). While checking the AC voltage drop across the resistor.
* Repeat the above with the AC connector reversed (it may be necessary to use an adaptor plug.) Any reading of 0.3 Volts RMS (equal to 0.2 mA AC) or more is DANGEROUS and MUST BE CORRECTED!



6.0 FUNCTIONAL SPECIFICATIONS

6.1 GENERAL INFORMATION

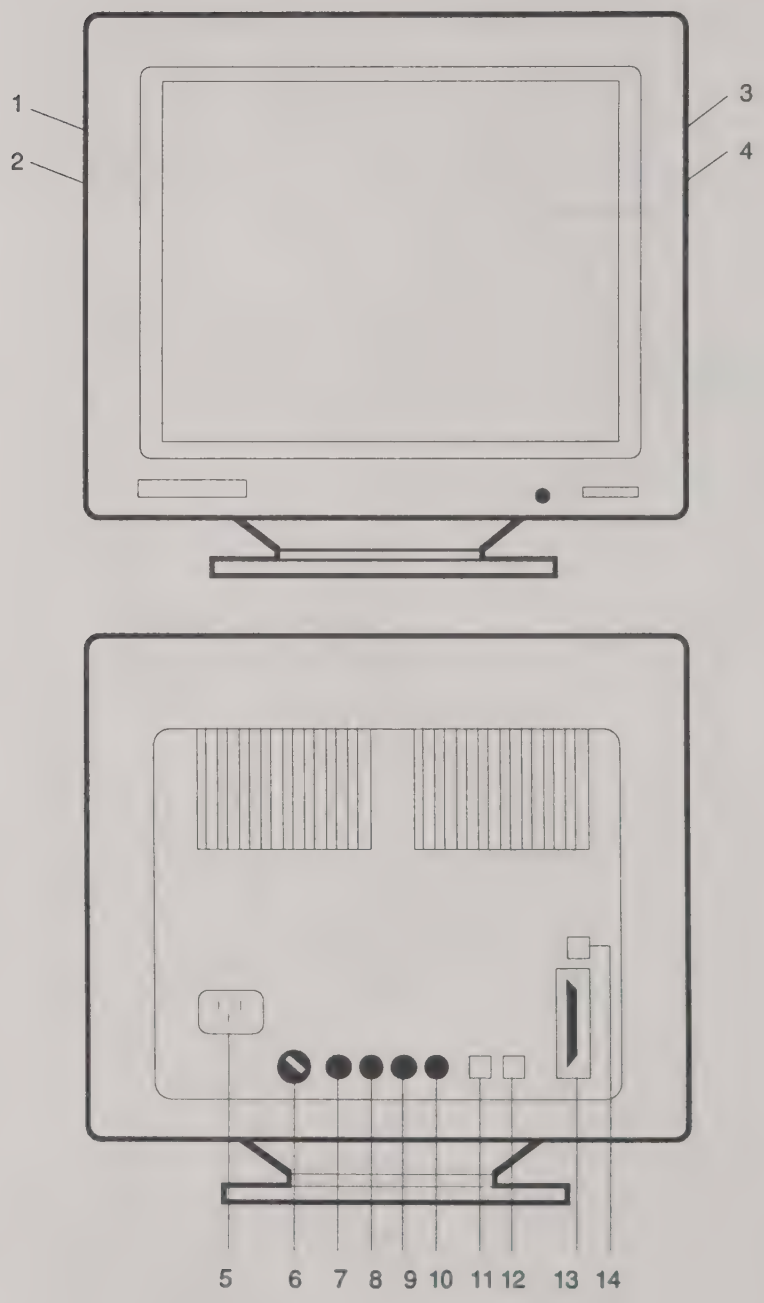
The **ULTRASYNC, ULTRA 14** and **ULTRA 16** have high resolution 12", 14" and 16" displays respectively for alphanumeric (text) and graphic use. They are capable of auto-synchronizing from 15 to 38 kHz horizontally and 45 to 120Hz vertically. An etched CRT is used for glare reduction. External controls consist of Contrast, Brightness Horizontal Size, Horizontal Position, Vertical Size, and Vertical Position. External switches consist of Power On, Text Mode, Analog/TTL, 110V/220V, 16/64 colors, and Under/Over Size. The **ULTRASYNC, ULTRA 14** and **ULTRA 16** are listed to UL 478 and CSA C22.2 No. 220, and certified to comply with the Class B limits pursuant to Subpart J of part 15 of FCC rules.

6.2 User Controls Information

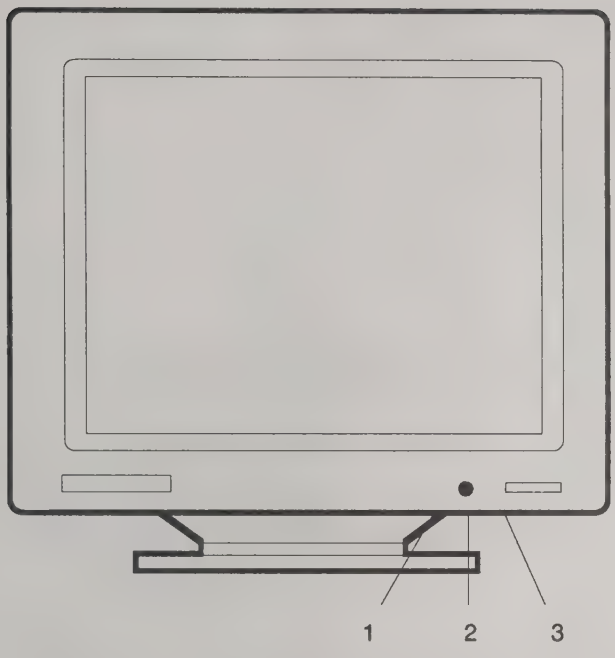
The Princeton **ULTRASYNC Series** offers convenient controls and rear-access selectors for ease of use and adjustment (*see diagrams on pages 7 & 8):*

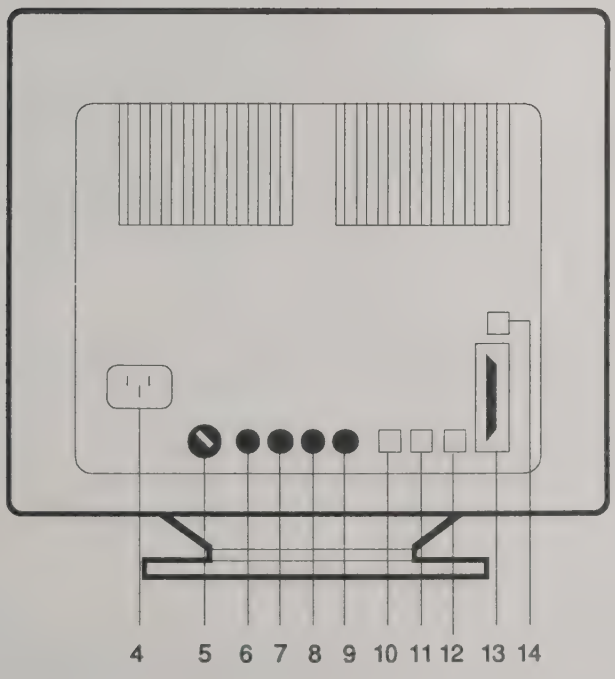
U/SYNC U/14 #	U/16 #	Description	Action
1	1	Brightness	Adjusts the brightness of the display.
2	2	Contrast	CGA mode adjusts the half intense colors. EGA mode adjusts the 1/3 & 2/3 intense colors. Analog mode adjusts the contrast of all intensities.
3	3	I/O	Power On/Off switch.
4	12	Text	When the monitor is turned on, normal colors are produced. On each successive push of the button, text is produced in the following modes: TTL Mode: Green on black background Amber on black background White on blue background Return to normal colors Analog Mode: Amber on black background Cyan on black background Green on black background Return to normal colors
5	4	AC Plug	Input for 110/220 VAC power cord.
6	5	110/220 VAC Switch	Selector for: 120 VAC, 60 Hz for North American Users - OR - 220/240 VAC, 50 Hz for European Users
7	6	V-POS	Positions the display vertically.
8	7	V-SIZE	Adjusts the vertical size.
9	8	H-POS	Positions the display horizontally.
10	9	H-SIZE	Adjusts the horizontal size.
11	10	Under/ Overscan/ Zoom	Designed to expand the IBM CGA mode to cover the standard area. Can be used to enlarge the screen for a borderless display in other modes.
12	11	16/64 Colors	Used only in TTL mode. Out for IBM TTL standards. In for non-compatible TTL boards. Not operative in analog mode.
13	13	25-Pin Video Connector	Connector for all video cables and adaptors.
14	14	Analog/TTL	Push IN when running analog display adaptors such as IBM PGA, VGA, 8514/A & PS/2. Out for TTL input such as CGA, EGA, etc.

ULTRASYNC / ULTRA 14



ULTRA 16





ULTRASYNC Series General Specifications

	ULTRASYNC	ULTRA 14	ULTRA 16
Picture Tube:	12 inches diagonal, 90 degree deflection, .28 mm Dot Pitch Black Matrix Tube Non-glare, Direct Etch	14 inches diagonal, 90 degree deflection, .28 mm Dot Pitch Black Matrix Tube Non-glare, Direct Etch	16 inches diagonal, 90 degree deflection, .31 mm Dot Pitch Black Matrix Tube Non-glare, Direct Etch
Active Display Area:	Horizontal: 215mm Vertical: 165mm	Horizontal: 250mm Vertical: 185mm	Horizontal: 275mm Vertical: 205mm
Video Bandwidth:	30 MHz	45 MHz	45 MHz
Resolution:	Horizontal: 800 dots Vertical: 600 lines	Horizontal: 1024 dots Vertical: 768 lines	Horizontal: 1024 dots Vertical: 768 lines
Sync Signals:	TTL Positive or Negative, Composite or Separate, Sync on Green.		
Compatibility:	IBM XGA, 8514/A, SuperVGA (800 x 600), VGA, PGA, EGA, MDA, MCGA, CGA Apple Mac II, TrueVision Targa & Vista, Hercules and other compatibles		
Synchronization:	Horizontal: 15 - 38 kHz autosynchronous Vertical: 45 - 120 Hz autosynchronous		
Misconvergence	Center: within .3 mm, Circumference: within .6 mm		
Power Supply:	90 - 132/180 - 250 VAC, 49-61 Hz		
Environmental:	Operating Ambient Temperature: 0-40 Degrees Celsius Humidity: 5-80% Non-Condensing		
Input Connector:	DB 25-Pin		
Dimensions: (HxWxDmm)	312x321x362 including base	346x358x390 including base	420x426x407 including base
Weight:	28 lbs	35 lbs	45 lbs
Power Consumption:	85 watts maximum.	85 watts maximum.	90 watts maximum.
Standard Options:	HD / DB15 - DB25 Analog Cable DB9 - DB25 TTL Adaptor		

6.3 MODE INFORMATION

6.3.1 TTL mode Information

When in the TTL mode, the polarity of the vertical sync signal will change the function of the input pins as follows:

Pin #	16 Color	64 Color
1	**Ground**	**Ground**
2	**Ground**	**Red2**
3	**Red**	**Red**
4	**Green**	**Green**
5	**Blue**	**Blue**
6	**Intensity**	**Green2**
7	**No Connection**	**Blue2**
8	**Horizontal Sync**	**Horizontal Sync**
9	**Vertical Sync (+)**	**Vertical Sync (-)**

Note: (+) Indicates a positive direction pulse. (-) Indicates a negative direction pulse.

6.3.2 External Contrast Control Function

16 Color Mode: With the intensity bit low, the external contrast pot shall be operative and adjust the brightness of the half intense colors from full bright down to at least half bright. With the intensity bit high, the external contrast pot shall have no effect.

64 Color Mode: The external contrast pot shall only effect the 1/3 and 2/3 video levels. The contrast pot shall adjust the 2/3 levels from full bright to at least 1/2 bright and the 1/3 levels from almost extinction.

Analog Mode: The external contrast control shall always be operative. The minimum range shall approximately 1/4 the brightness of the full intense white, shall be produced.

Grey (16 Color Mode): When the R,G & B inputs are low and the intensity bit is high, a grey level of approximately 1/4 the brightness of the full intense white, shall be produced.

Brown (16 Color Mode): When the red and the green inputs are high and the blue and the intensity inputs are low, then brown shall be produced by displaying 1/2 red with 1/3 green.

6.4 VIDEO SIGNAL INFORMATION

TTL MODES:	CGA	EGA	MDA
Horizontal Resolution*:	640	640	720
Vertical Resolution*:	200	350	348
Horizontal Frequency *(KHz)*	15.75	21.8	18.432
Vertical Frequency *(Hz)*	60	60	50
Colors Displayable:	16	64	64
Character cell size*:	8x8	8x14	9x14
Characters per row*:	80	80	80
Rows per frame*:	25	25	25
Video Dot Frequency *(MHz)*:	14.318	16.257	16.257
Scanning Mode:	---------- Non-Interlaced -------		

* denotes typical specifications

VGA MODES:

Horizontal Resolution:	640	640	640	800	800
Vertical Resolution:	350	400	480	600	600
Horizontal Frequency *(KHz):*	31.47	31.47	31.47	31.47	31.47
Vertical Frequency *(Hz):*	70	70	60	56.2	60.3
Colors displayable:		---------- Infinite ----------			
Video Dot Frequency *(MHz):*	25.175	28.322	25.175	36	40
Scanning mode:		--------- Non-Interlaced --------			

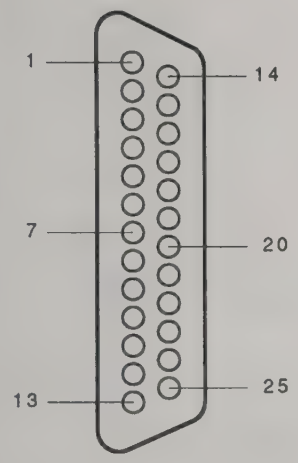
8514/A (1024x768) *(ULTRA 14 and ULTRA 16):*

Horizontal Resolution:	1024
Vertical Resolution:	768
Horizontal Frequency *(KHz):*	36.10
Vertical Frequency *(Hz):*	87.72
Colors displayable:	Infinite
Video Dot Frequency *(MHz):*	44.900
Scanning Mode:	Interlaced

OTHER MODES:	PGA	MAC II
Horizontal Resolution:	640	640
Vertical Resolution:	480	480
Horizontal Frequency *(KHz):*	30.48	35.00
Vertical Frequency *(Hz):*	60	66.5
Colors displayable:	256	Infinite
Video Dot Frequency *(MHz):*	25	30.24
Scanning Mode:	--- Non-Interlaced ---	

The actual specifications will depend on the controlling video board used.

ULTRASYNC SERIES 25-PIN CONNECTOR PIN-OUT ADDRESS



PIN #	TTL	Analog
1	Ground	Red
2	Red 2 or Ground	Green
3	Red	Blue
4	Green	Composite Sync or H. Sync
5	Blue	PGC Mode
6	Green 2 or Intensity	Ground
7	Blue 2	Ground
8	H. Sync	Ground
9	V. Sync	V. Sync
10		No Connection
11		Red
12		Green
13		Blue
14		No Connection
15		No Connection
16		Ground
17		Ground
18		Ground
19		No Connection
20		Ground
21		Ground
22		No Connection
23		H. Sync
24		V. Sync
25		No Connection

Pin-Out configurations for VGA HD DB-15 Video Cable

DB-15		DB-25
1	Red	11
2	Green	12
3	Blue	13
4	No Connection	14
5	No Connection / Self Test	15
6	Red Ground	16
7	Green Ground	17
8	Blue Ground	18
9	No Connection	19
10	Logic Ground	20
11	Color Ground	21
12	No Connection / Mono Ground	22
13	Horizontal Sync	23
14	Vertical Sync	24
15	No Connection	25

Twisted Pairs (with respect to DB-25 pin connector):

11 with 16, 12 with 17, 13 with 18, 20 with 23, 21 with 24

Pin-Out configurations for TTL (EGA / CGA) Video Cable

DB-9		DB-25
1	Ground	1
2	Red 2	2
3	Red	3
4	Green	4
5	Blue	5
6	Green 2	6
7	Blue 2	7
8	Horizontal Sync	8
9	Vertical Sync	9

Pin-Out configurations for Apple Macintosh AC-100 Video Cable

DB-15		DB-25
1	Red Ground	16
2	Red	11
3	Composite Sync	23
4	Composite Sync Ground	20
5	Green	12
6	Green Ground	17
9	Blue	13
13	Blue Ground	18

6.5 Signal levels, Impedance, and Duty Factors

6.5.1 TTL Video (R, G, B, I, R2, G2, B2)

Positive video:	Color : 2.4V to 5.0V, (High level)
Black :	0.0V to 0.8V, (Low level)
Impedance:	470 ohms +/- 5% 50Pf MAX

6.5.2 Analog Video (Analog RGB)

Positive video:	0.70V p-p +/- 0.04V (Video information only, excluding any sync info.)
Impedance:	75 ohm +/- 5% 50Pf MAX

6.5.3 Horizontal Sync/Composite Sync

Positive or Negative polarity:	2.4V to 5.0V, (high level) 0.0V to 0.8V, (low level)
Impedance:	470 ohms +/-5% 1200 Pf MAX
Duty Factor:	H. Period > 5x H. Sync Pulse Width

6.5.4 Vertical Sync

+ or - polarity:	2.4V to 5.0V, (high level) 0.0V to 0.8V, (low level)
Impedance:	470 ohms +/-5% .01 Uf MAX
Duty Factor:	Vertical Period > 5x Vertical Sync Pulse Width

6.5.5 Sync on Green signal

-0.3V Peak +/- 0.04V below 0 volt video signal level

6.6 BLANKING

Internal blanking shall be done during retrace times.

Maximum retrace times:

Horizontal:	4.00 US (10% to 90%) maximum
Vertical:	550 US (10% to 90%) maximum

6.7 ELECTRICAL SPECIFICATIONS

Power Connector:	IEC 3 pin type connector (IEC 320/CEE 22)
Voltage:	90-132 / 180-264 VAC RMS (external adjustable switch for selection of range)
AC Frequency:	49 Hz to 61 Hz
AC Current Load:	1.5 AMP RMS Maximum under any combination of frequencies and brightness levels

6.7 ELECTRICAL SPECIFICATIONS *(continued)*

Power Consumption:	85 Watts
Operating ambient Temperature:	0-40 degrees C, 5-80% humidity (non -condensing) 10,000 ft. altitude.
High Voltage Output:	24 KV
High Voltage Regulation:	The raster size does not vary by more than 4% over full range of brightness.
Temperature Drift:	
Video:	Less than 20% brightness change.
Size:	Less than 3% of width, less than 3% of height.
Offset:	Less than 2% of width, less than 2% of height.

6.8 DISPLAY CHARACTERISTICS

Cathode Ray Tube (CRT):

ULTRASYNC:	12" diagonal/11.5"V
ULTRA 14:	14" diagonal/13.5"V
ULTRA 16:	16" diagonal/15.5"V
	All 90 degree, Black Matrix with dark glass (56% Transmission)
Phosphor:	P22-RGB
Dot Pitch:	
ULTRASYNC:	0.28mm.
ULTRA 14:	0.28mm.
ULTRA 16:	0.31mm.
Anti Glare:	Etched CRT
Light Output:	
ULTRASYNC:	55FL minimum.
ULTRA 14:	40FL minimum.
ULTRA 16:	30FL minimum.

Active Display Size:

ULTRASYNC:	215 mm x 160 mm +/-5mm (w/ Color Hue Pattern at max brightness for the CGA, EGA and PS/2 modes)
	207 mm x 160 mm +/-5mm (w/ color at maximum brightness for the PGA modes)
ULTRA 14:	250 mm x 185 mm +/-5mm (w/ Color Hue Pattern at max brightness for the CGA, EGA and PS/2 modes)
	240 mm x 185 mm +/-5mm (w/ color at maximum brightness for the PGA modes)
ULTRA 16:	275 mm x 205 mm +/-5mm (w/ Color Hue Pattern at max brightness for the CGA, EGA and PS/2 modes)
	265 mm x 205 mm +/-5mm (w/ color at maximum brightness for the PGA modes)

Pincushion:

ULTRASYNC:	2.0mm Max (Left and Right side) 2.2mm Max (Top and Bottom)
ULTRA 14:	2.3mm Max (Left and Right side) 2.6mm Max (Top and Bottom)
ULTRA 16:	2.7mm Max (Left and Right side) 2.9mm Max (Top and Bottom)

6.8 DISPLAY CHARACTERISTICS *(continued)*

Barrel:

ULTRASYNC:	0.4mm Max (All sides)
ULTRA 14:	0.5mm Max (All sides)
ULTRA 16:	0.55mm Max (All sides)

Tilt:

ULTRASYNC:	+/- 1.0mm Maximum
ULTRA 14:	+/- 1.1mm Maximum
ULTRA 16:	+/- 1.2mm Maximum

Trapezoid: 1.2% Maximum (horizontal and vertical)

Focus: With "#" displayed in all character positions at 28.322 MHz, 720 x 400 pixels at 15FL, all the lines of the character should be resolvable.

6.9 MECHANICAL & MISCELLANEOUS

Dimensions:

ULTRASYNC:	312mm(H) x 321mm(W) x 362mm(L) (includes base)
ULTRA 14:	346mm(H) x 358mm(W) x 390mm(L) (includes base)
ULTRA 16:	420mm(H) x 426mm(W) x 407mm(L) (includes base)

Weight:

ULTRASYNC:	28 lbs.
ULTRA 14:	35 lbs.
ULTRA 16:	45 lbs.

Cabinet Material: Flame-resistant plastic

Cabinet Color: Grey.

Accessories: Shielded signal cable with male DB-25 to male High-density DB-15 for Analog operation, power cord, **ULTRASYNC Series** Operations Manual, Princeton Graphic Systems Warranty card and DB-25 to DB-9 for TTL operation.

6.10 SIGNAL & TIMING SPECIFICATIONS

TTL MODES:	**CGA**	**EGA**	**MDA**
Video Dot Frequency *(MHz):*	14.318	16.257	16.257
Horizontal-			
Frequency *(KHz):*	15.75	21.80	18.432
Period *(ms):*	63.69	45.87	54.25
Active Video *(us):*	44.70	39.69	44.29
Blanking *(us):*	18.99	6.18	9.96
Pulse Width *(us):*	+3.97	+4.64	+8.30
Back Porch *(us):*	8.34	1.40	1.11
Front Porch *(us):*	6.68	0.14	0.55
Vertical-			
Frequency *(Hz):*	60	60	50
Period *(ms)*	16.67	16.67	20.00
Active Video *(ms):*	12.74	15.92	18.79
Blanking *(ms):*	3.93	0.75	1.21
Pulse Width *(ms):*	+0.19	-0.60	-0.87
Back Porch *(ms):*	2.14	0.10	0.33
Front Porch *(ms):*	1.60	0.05	0.01

(- or + denotes signal polarity)

VGA MODES:

Vertical Resolution	350	400	480	600	600
Video Dot Frequency *(MHz):*	25.175	28.322	25.175	36.00	40.00
Horizontal-					
Frequency *(KHz):*	31.47	31.47	31.47	35.156	37.88
Period *(us):*	31.78	31.78	31.78	28.44	26.40
Active Video *(us):*	25.42	25.42	25.42	22.22	20.00
Blanking *(us):*	6.36	6.36	6.36	6.22	6.40
Pulse Width *(us):*	+3.81	-3.81	-3.81	2.00	3.20
Back Porch *(us):*	1.91	1.91	1.91	3.55	2.20
Front Porch *(us):*	0.64	0.64	0.64	0.67	1.00
Vertical-					
Frequency *(Hz):*	70	70	60	56.25	60.32
Period *(ms):*	14.28	14.28	16.67	17.78	16.58
Active Video Period *(ms):*	11.13	12.73	15.27	17.06	15.84
Blanking *(ms):*	3.15	1.55	1.40	0.72	0.74
Pulse Width *(ms):*	-0.06	+0.06	-0.06	0.06	0.10
Back Porch *(ms):*	1.91	1.11	1.05	0.63	0.61
Front Porch *(ms):*	1.18	0.38	0.29	0.03	0.03

8514/A (1024x768) MODE *(ULTRA 14 and ULTRA 16):*

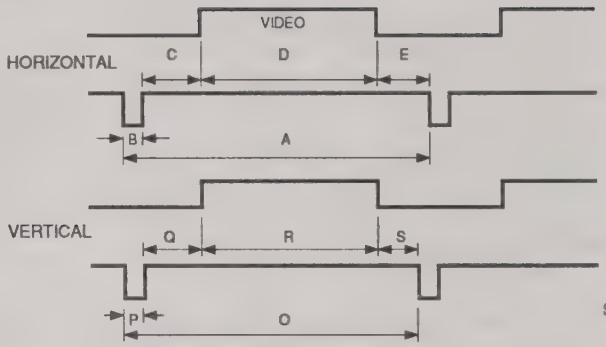
Vertical Resolution:	768	Video Dot Frequency:	44.90
Horizontal-		Vertical-	
Frequency *(KHz):*	35.52	Frequency *(Hz):*	87.00
Period *(us):*	28.15	Period *(ms):*	11.49
Active Video *(us):*	22.22	Active Video *(ms):*	10.81
Pulse Width *(us):*	3.92	Blanking *(ms):*	0.68
Blanking *(us):*	5.35	Pulse Width *(ms):*	0.11
Back Porch *(us):*	1.25	Back Porch *(ms):*	0.56
Front Porch *(us):*	0.18	Front Porch *(ms):*	0.01

OTHER MODES:	**MAC II**	**PGA(480)**	**PGA (400)**
Video Dot Frequency:	30.24	25.00	25.00
Horizontal-			
Frequency *(KHz):*	35.00	30.48	30.48
Period *(us):*	28.57	32.80	32.80
Active Video *(us):*	21.20	25.50	25.50
Pulse Width *(us):*	2.11	-4.60	-4.60
Blanking *(us):*	7.37	7.30	7.30
Back Porch *(us):*	3.15	2.70	2.70
Front Porch *(us):*	2.11	0.00	0.00
Vertical-			
Frequency *(Hz):*	66.50	60.00	60.00
Period *(ms):*	15.03	16.67	16.67
Active Video *(ms):*	13.74	15.75	13.12
Blanking *(ms):*	1.29	0.92	3.55
Pulse Width *(ms):*	0.09	-0.07	-0.07
Back Porch *(ms):*	1.11	0.80	2.10
Front Porch *(ms):*	0.09	0.05	1.38

- or + denotes signal polarity

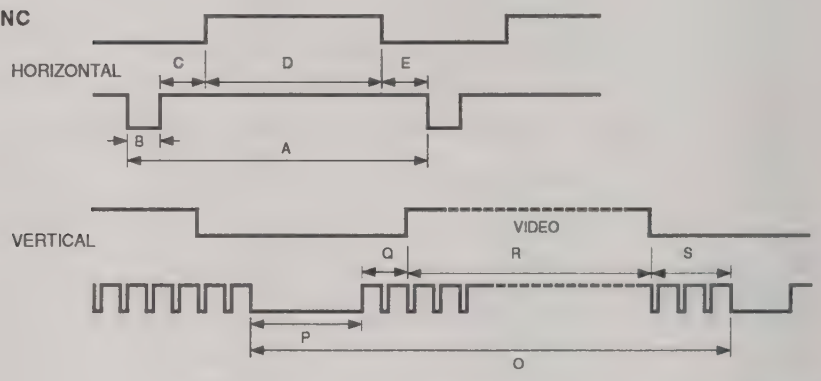
6.11 TIMING CHART

SEPARATE SYNC



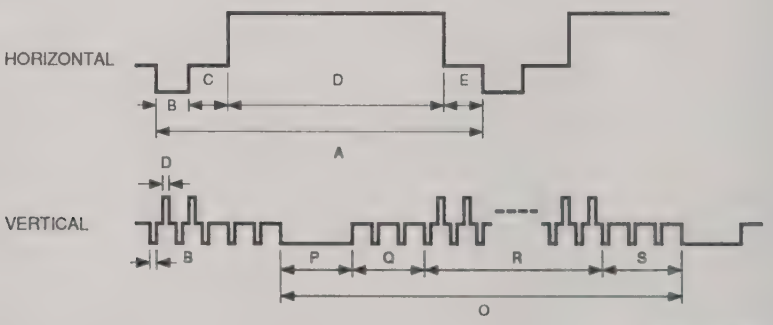
Sync Polarity: Positive/Negative

COMPOSITE SYNC



Sync Polarity: Positive/Negative

SYNC ON GREEN



Sync Polarity: Negative

HORIZONTAL:		VERTICAL:	
A	Horizontal Period	O	Vertical Period
B	Pulse Width	P	Pulse Width
C	Back Porch	Q	Back Porch
D	Active Video	R	Active Video
E	Front Porch	S	Front Porch

7.0 SETUP PROCEDURE

7.0.1 PRELIMINARY NOTES AND DEFINITIONS

7.0.1 Unless otherwise stated, all control directions are referenced from the front of the unit.

7.0.2 A "Standard Video source" is a video source which operates in any of the following standard display modes: PS/2, VGA, EGA, or CGA.

7.0.3 If a particular adjustment does not require a specific display mode to be used, then any of the display modes listed above may be used for that adjustment.

7.1 INITIAL CONTROL SETTINGS

7.1.0 Set the RGB Gain Controls, (VR201, VR202, VR203), fully CCW to their maximum positions. These controls are located along the top edge of the Video PCB.

7.1.1 Set the RGB Bias Controls, (VR101, VR102, VR103), fully CW to their maximum positions. These controls are located along the top edge of the CRT PCB.

7.1.2 Set the RGB Sub Contrast Controls, (VR205, VR206, VR207), fully CW to their minimum positions. These controls are located along the top edge of the Video PCB.

7.1.3 Set the G_2 control to its minimum position, (fully CCW when viewed from the rear of the unit. This Control is the bottom most control on the Flyback Transformer.

7.1.4 Set the Focus Control to the center of its range. This control is the top most control on the Flyback Transformer.

7.1.5 Set the HV-ADJ Control, (VR602), to its minimum position, (fully CCW when viewed from the bottom of the unit). This control is located near the center rear of the Main PCB.

7.1.6 Set the X-RAY Protect Control, (VR505), to its maximum value, (fully CW when viewed from the bottom of the unit). This control is located near the center rear of the Main PCB. Later units use fixed resistors in place of this control so no adjustment is required.

7.1.7 Set the SOG White Balance Control, (VR204) to its maximum position, (fully CW when viewed from the rear of the unit). This control is located on the upper rear edge of the Video PCB.

7.1.8 Set the B+ ADJ Control, (VR301), fully CW to its minimum position. This control is located near the upper front edge of the Power Supply PCB.

7.1.9 Set the SUB CONTRAST RANGE Control, (VR208), fully CW to its maximum position. This control is located on the upper edge of the Video PCB toward the rear of the unit.

7.1.10 Set the following controls to the center of the rotation range:

7.1.10.1	**H-HOLD Control**	(VR502)
7.1.10.2	**V-HOLD Control**	(VR401)
7.1.10.3	**V-LIN Control**	(VR402)
7.1.10.4	**PIN-GAIN Control**	(VR407)
7.1.10.5	**PIN-PHASE Control**	(VR408)
7.1.10.6	**SUB H-POSITION Control**	(VR507)
7.1.10.7	**CS-ADJ Control**	(VR506)
7.1.10.8	**H-CENTER Control**	(VR506)

All of the above controls are located on the Main PCB.

7.1 INITIAL CONTROL SETTINGS *(continued)*

7.1.11 Set all of the rear panel controls to the center of their ranges. These controls are:

7.1.11.1 H-SIZE Control
7.1.11.2 V-SIZE Control
7.1.11.3 H-POSITION Control
7.1.11.4 V-POSITION Control

7.1.12 Set the Analog/TTL Switch to the proper position depending on the video source used .

7.1.13 Set the 16/64 Color button and the OVER/UNDER Scan button to the OUT positions.

7.2 INITIAL MONITOR OPERATION

7.2.1 Connect the unit to a standard video source using the appropriate signal cable and supply power to the monitor.

7.2.2 Set the External Brightness and Contrast Controls to their maximum positions, (rotate toward the back of the unit).

7.2.3 Adjust the G_2 Control, (the lower of the two controls on the FBT), for a visible display of normal brightness. This control will be set to its proper value in a later step.

7.2.4 Adjust the H-HOLD, (VR502) and the V-HOLD, (VR 401), controls for a stable display. These controls will be set to their proper values in later steps.

7.2.5 Adjust the Focus Control, (the upper of the two controls on the FBT), to obtain a readable display. This control will be set to its proper value in a later step.

7.3 POWER SUPPLY ADJUSTMENT

7.3.1 Operate the unit from a video source which operates at or near 31.5 kHz Horizontal Scan Frequency, (such as PS/2, VGA, or Sigma Color 400 cards).

7.3.2 Adjust the B+ ADJ Control, (VR301), so that the output of the 110 Volt Supply is between 108 and 112 Volts DC. This measurement should be made at the 110 Volt Pin of W501 on the bottom of the Main PCB.

7.4 HV ADJUSTMENT

7.4.1 If the monitor uses fixed resistors for VR505, perform step 7.4.6 only.

7.4.2 Operate the unit from a standard video source and display a blank screen.

7.4.3 Set the External Brightness and Contrast Controls to their maximum positions.

7.4.4 Adjust the HV-ADJ Control, (VR602), for an Anode Voltage of 26.8 to 27.2 KVolts.

7.4.5 Slowly adjust the X-RAY PROTECT Control, (VR505), down until the HV Supply just starts to shut down.

7.4.6 Adjust the HV-CONTROL, (VR602), for an Anode Voltage of 23.9 to 24.1 KVolts.

7.5 HORIZONTAL ADJUSTMENT PROCEDURE

7.5.1 Operate the unit from an EGA Video source, (Horizontal Frequency = 21.8 kHz).

7.5.2 Adjust CS-ADJ Control, (VR506), for DC Voltage of 3.40 volts to 3.50 Volts at TP1.

7.6 HORIZONTAL HOLD ADJUSTMENT PROCEDURE

7.6.1 Please refer to 7.5.1 above.

7.6.2 Short pin 16 of I401, (HA11235), to ground.

7.6.3 Adjust the H-HOLD Control, (VR502), until the period of the signal measured at pin 13 of I508, (74LS221), is 39 to 41Us.

7.6.4 Remove the short from pin 16 of I401.

7.7 HORIZONTAL CENTERING PROCEDURE

7.7.1 Operate the unit from a VGA Signal source, (either a PS/2 or a VGA card). Display a full white screen. Adjust the External Contrast control for minimum and adjust the External Brightness Control so that the background raster is just visible.

7.7.2 Adjust Internal H-CENTER Control, (VR501), to center the raster on the CRT face.

7.7.3 Adjust External H-POSITION Control, (VR507), to center of its range.

7.7.4 Adjust SUB H-POSITION Control, (VR507), to center the display within the raster area.

7.8 HORIZONTAL SIZE ADJUSTMENT

7.8.1 Operate the unit from a standard Video source. Display a full white screen. Adjust the External Contrast Control to maximum. Adjust the External Brightness control for a dim display.

7.8.2 Adjust the H-SIZE Control on the rear of the unit for a horizontal display size of 210 to 220mm for the ULTRASYNC, (245-255mm for the ULTRA 14, 270-280mm for the ULTRA 16).

7.9 VERTICAL ADJUSTMENT PROCEDURE

7.9.1 Operate the unit from an EGA Video source (21.8kHz).

7.9.2 Adjust the V-HOLD Control, (VR401), to the center of its lock range.

7.9.3 Adjust the External V-POSITION control to center the display on the screen.

7.9.4 Adjust the External V-SIZE Control for a vertical display size of 155 to 165mm for the ULTRASYNC, (180 to 190mm for the ULTRA 14, 200 to 210mm for the ULTRA 16).

7.10 VERTICAL LINEARITY ADJUSTMENT

7.10.1 Display a crosshatch test pattern in the CGA mode, (15.75KHz Horizontal and 60 Hz Vertical).

7.10.2 Adjust the V-LIN Control, (VR402), for the best overall vertical linearity across the display.

7.11 PINCUSHION ADJUSTMENT PROCEDURE

7.11.1 Display an all white screen in the CGA mode.

7.11.2 Adjust the PIN-GAIN Control, (VR407), and the PIN-PHASE Control, (VR408), for the least geometric distortion.

7.12 CRT BIAS ADJUSTMENT

7.12.1 Operate the unit from a Standard EGA, VGA, or PS/2 Video source. Set the external Contrast and Brightness Controls to maximum.

7.12.2 Display a blank screen and turn G_2 down all the way. G_2 is the lower of the two controls on the FBT.

7.12.3 Slowly adjust G_2 up until the background raster is just visible. Note what color appears first.

7.12.4 Adjust the CRT-Bias Controls, (VR101, VR102, VR103), of the other two colors to obtain a white raster. These controls are located on the top edge of the CRT PCB.

7.13 RGB GAIN ADJUSTMENT

7.13.1 Operate the unit from a standard EGA, VGA, or PS/2 Video Source. Set the External Contrast Control to maximum. Set the External Brightness Control to the point where the background raster just disappears.

7.13.2 Display a white 3" square in the center of the screen.

7.13.3 Adjust the RGB GAIN Controls, (VR201, VR202, VR203), to obtain a white square of 60 Foot Lamberts +/- 5FL for the ULTRASYNC, (45 FL for the ULTRA 14, 35 FL for the ULTRA 16). These Controls are located along the upper edge of the Video PCB. If a Color Meter is not available, adjust each control to obtain a 35 Volt p-p voltage swing at its respective cathode on the CRT PCB (25 Volt p-p for ULTRA 14, 20 Volt p-p for the ULTRA 16). Then adjust the controls slightly as required to obtain the proper white color.

7.14 FOCUS ADJUSTMENT

7.14.1 Operate the unit from a standard video source and display a full screen of text at a normal brightness level.

7.14.2 Adjust the FOCUS Control, (the upper of the two controls on the FBT), for overall focus across the entire display.

7.15 CONTRAST ADJUSTMENT PROCEDURE

7.15.1 Display an RGB 0, 1/3, 2/3, FULL test pattern in the EGA mode.

7.15.2 Back the External Contrast Control off 1/8 of a turn.

7.15.3 Turn down each color's SUB CONTRAST CONTROL, (VR205, VR206, VR207), until its respective 2/3 color just starts to attenuate.

7.15.4 Turn the External Contrast control to minimum and adjust the Sub Contrast Range Control, (VR208), so the intensity of the 2/3 intense white square is about 1/3 of its value when the external contrast control was set to maximum.

7.16 SYNC ON GREEN (SOG) ADJUSTMENT

7.16.1 Display a 3" white square in the SOG mode.

7.16.2 Adjust the SOG Color Balance Control, (VR204), for a white square.

7.16.3 Display a full screen of text at normal brightness level in the EGA mode.

7.16.4 Adjust the FOCUS Control for the best overall focus across the display.

7.17 CONVERGENCE ADJUSTMENT

7.17.1 Display a magenta crosshatch pattern.

7.17.2 Loosen locking ring on yoke and remove all glue from 4 and 6-pole magnet rings.

NOTE: DEGAUSS CRT AFTER 7.17.3, 7.17.5, 7.17.6, 7.17.7.

7.17.3 Adjust for best overall red-blue convergence by:

a) Changing the angle of one 4-pole magnet ring in respect to the other ring to converge red and blue vertically. *Refer to diagram on the following page.*

b) Rotating both 4-pole magnet rings simultaneously to converge red and blue horizontally. *Refer to diagram on the following page.*

7.17.4 Display white crosshatch pattern.

7.17.5 Without disturbing the 4-pole magnets, adjust the 6-pole magnets to obtain the best overall green-to-magenta convergence by:

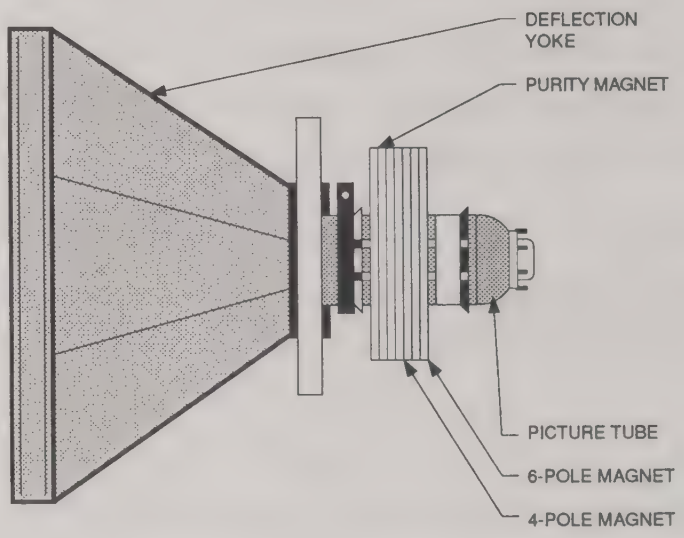
a) Changing the angle of one 6-pole magnet ring in respect to the other ring to converge magenta and green vertically. *Refer to diagram on the following page.*

b) Rotating both 6-pole magnet rings simultaneously to converge magenta and green horizontally. *Refer to diagram on the following page.*

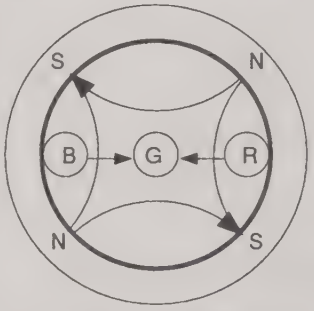
7.17.6 Tighten locking ring.

7.17.7 Double check convergence to make sure that tightening the locking ring did not change the magnet positions. If convergence has changed, start again.

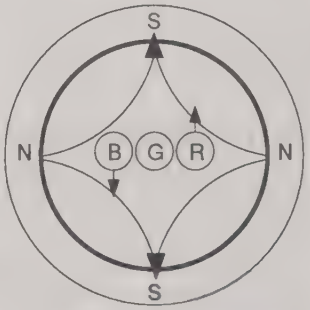
DEFLECTION YOKE DIAGRAM



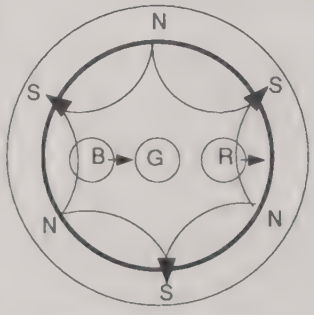
DEFLECTION YOKE MAGNET DIAGRAM



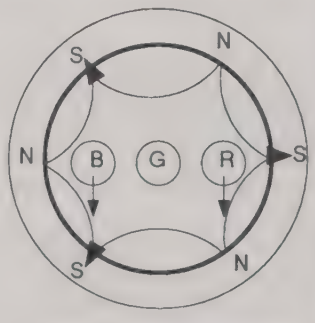
Beam migration in application of 4-pole magnets



Beam migration in application of 4-pole magnets rotated

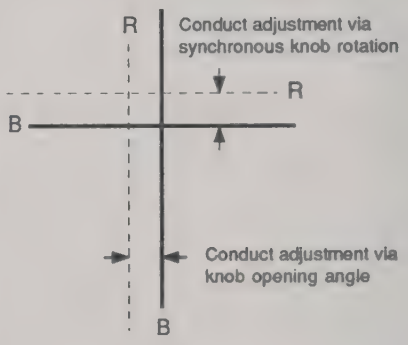


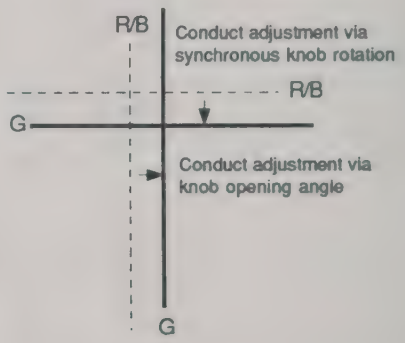
Beam migration in application of 6-pole magnets



Beam migration in application of 6-pole magnets rotated

CONVERGENCE ADJUSTMENT DIAGRAM





9.0 THEORY OF OPERATION

INTRODUCTION

The Ultrasync monitors contain a tube and yoke assembly and four boards: The CRT board, the power supply board, the video board, and the main board. The key sections of the main board include the sync processor, horizontal/vertical processor, horizontal deflection/high voltage (HV) power supply, vertical deflection, and mode adjust.

9.1 CRT & YOKE ASSEMBLY

The Ultrasync is equipped with a 12" Hitachi 90 degree magnetic deflection CRT. The CRT has a P22 phosphor screen and uses an in-line gun. The CRT has a 0.28mm dot pitch. Some early Ultrasync monitors are equipped with a 12" Matsushita 90 degree magnetic deflection CRT.

The Ultra 14 is equipped with a 14" Hitachi 90 degree magnetic deflection CRT. The CRT has a P22 phosphor screen and uses an in-line gun. The CRT has a 0.28mm dot pitch.

The Ultra 16 is equipped with a 16" Matsushita 90 degree magnetic deflection CRT. The CRT has a P22 phosphor screen and uses an in-line gun. The CRT has a 0.29mm horizontal dot pitch and a 0.31mm vertical dot pitch.

The CRT is driven by the video drivers and the horizontal deflection/HV power supply. The yoke is driven by the horizontal deflection/HV power supply and the vertical driver.

9.2 POWER SUPPLY BOARD

9.2.1 OUTPUT VOLTAGES

The power supply generates 5 DC voltages used to run the monitor: +110V, +80V, +19V, +5V, -8V. The 110V provides the B+ voltage for the high voltage/deflection power supply. It also gets dropped down to 20V through R525 and ZD501 to supply power to the horizontal/vertical processor I401, and gets dropped down to 10V via ZD601 for the G1 circuit.

The 80V is used exclusively to power the cathode drivers located on the CRT board.

The +19V is used throughout the monitor. It powers the vertical driver, vertical position, and gets boosted to 38V via voltage doubler Q402, D407, C417, and R422 - R424 during retrace.

The +19V gets dropped to +16V via I406. The +16V supply is used to provide power to the horizontal size circuit, mode select circuit, automatic brightness limit (ABL) circuit, CS adjust circuit, horizontal/vertical processor I401, and the HV power supply processor I505. The +16V is also dropped to +5V via I510. This 5V supply (do not confuse this supply with the +5V from the power supply board) powers the sync processor and part of the text mode circuit. An additional +5V supply is generated from the +16V via R547, R575, R575A, and ZD504. This supply powers the sub-horizontal position (sub-H pos) control circuit.

The +19V gets dropped to +15V via I209 and +12V via R282 and ZD201. These voltages provide power to the video preamplifier.

The +5V supply is used to power the portion of the video preamplifier dedicated to TTL level video signals. This supply also powers the horizontal and vertical sync buffers.

The -8V supply is used to provide a negative supply for I402. It is also dropped to -6.3V via R580 and R581 to provide the CRT with a filament voltage.

9.2.2 OPERATION

The power supply topology used is a flyback converter. I301 (TDA4601) is the control IC. This IC regulates changes in line voltage by using pulse width modulation (PWM) and regulates changes in load by frequency modulation (FM). I301 regulates the outputs through a feedback winding (pins 1, 4) referenced to the primary side of transformer T302. The transformer is wound in such a way that output load regulation is achieved through the coupling between windings.

Initial start-up voltage is obtained via R306 and R307. This voltage is rectified and smoothed by D310 and C308. When the voltage at I301-9 reaches 11 volts the IC becomes active, sending pulses to the power transistor Q302. At this point all of the secondary windings will continue to charge up until they reach their final voltage. After the IC becomes active the voltage on pin 9 (typically 15V) is controlled by the rectified output of an auxiliary winding (T302 pin 2).

In some cases the initial draw of start-up current from I301 will cause the voltage on C308 to drop below 7V. If this happens the pulses to the power transistor will stop and the start-up cycle will begin again. To prevent this from happening an additional power boost circuit was added. Additional start-up power is provided through T302 pin 1. This voltage is rectified and smoothed by D304 and C311. Current through R312 is applied to the base of Q303 and ZD301. ZD301 clamps the base of Q303 to 13V and thus clamps the emitter of Q303 to 12.7V. The boost supply remains active during start-up only. Once the auxiliary supply charges back up to its normal operating level the emitter-base junction of Q303 becomes back-biased, turning Q303 off. At this point the power supply becomes free running, with the frequency determined by the output load. Typical operating frequencies will range from 25kHz to 35kHz.

I301-4 simulates the collector current of Q302 and thus provides current limiting of the output switch. When the voltage at this pin reaches 4V the PWM circuit resets. R305, R321 and C310 set the time constant. The complete pin configuration of the TDA4601 is shown below.

PIN #	FUNCTION
1	Vref output (typically 4.2 volts)
2	Zero passage identification
3	Input regulating amplifier, overload amplifier
4	Collector current simulation
5	Possible connection for additional protective circuit
6	Ground
7	DC voltage output for charging the coupling capacitor
8	Pulse output used to drive the switching power transistor
9	Vcc, typically 15V

9.3 MAIN BOARD

9.3.1 SYNC INPUT

The incoming horizontal and vertical sync signals are applied to I210-1 and I206-13 respectively. Sync is also directly applied to the sync processor (I501) on the main board. Clamp diodes D239 - D242 provide ESD protection. The horizontal and vertical sync signals are converted to a mode signal (MH, MV) at I210-4 and I206-10 respectively. This information is used to determine the horizontal and vertical display size for CGA, MDA, EGA, PGA, MCGA, VGA and 8514/A mode.

9.3.2 HORIZONTAL SYNC PROCESSOR

The next stage of the sync processing involves automatic polarity correction. Both sync signals must be converted to a positive sync signal, regardless of the polarity of the input signal. The horizontal signal is polarity corrected by R512, C517 and an exclusive OR (X-OR) gate of I501. A negative sync signal will be averaged by the RC network to produce a logic "1" signal. In this mode the X-OR will invert the incoming sync, producing a positive sync signal at I501-3. If the incoming sync is positive, the average voltage at I501-1 will be logic "0". In this mode the X-OR acts as buffer, passing the incoming sync signal to the output.

9.3.3 VERTICAL SYNC PROCESSOR

The vertical auto polarity circuit works the same way. The vertical signal is polarity corrected by R402, C403 and an exclusive OR (X-OR) gate of I501. A negative sync signal will be averaged by the RC network to produce a logic "1" signal. In this mode the X-OR will invert the incoming sync, producing a positive sync signal at I501-11.

If the incoming sync is positive, the average voltage at I501-12 will be logic "0". In this mode the X-OR acts as buffer, passing the incoming sync signal to the output.

9.3.4 VERTICAL SYNC STRIPPER

For composite sync inputs or SOG inputs, the vertical sync pulse will contain horizontal sync pulses. This signal originates at I501-6. R401, R403 and C401 integrates the sync pulse. The time constant is large enough to strip the horizontal sync information from the signal. D411 and R418 are used to create a fast discharge path when the sync pulse goes to zero.

In the absence of a composite sync signal I501-9 must be grounded. This is accomplished by applying the sync pulse from I501-11 to the base of Q414 via R456. D409 and C442 create a DC supply for this circuit that gets recharged with each new sync pulse. Q414 gets turned on, grounding I501-9.

9.3.5 74LS221 OPERATION

The 74LS221 is a monostable multivibrator (one-shot) used in the monitor at I502, I507, and I508. It has negative-transition-triggered inputs (pins 1, 9) and positive-transition-triggered inputs (pins 2, 10). The output pulse width is defined by the relationship: Tw(out)= Cext * Rext * ln2. Proper operation of these devices is critical to monitor picture phase and stability.

9.3.6 SYNC ON GREEN DISABLE

The Ultrasync is designed to lock on sync-on-green (SOG) signals. In the absence of SOG, this circuit must be deactivated. A separate or composite horizontal sync signal will be applied to a "one-shot" I502- 10. The output at pin 5 will be averaged at C573 and used to turn on Q518. This will disable the SOG input and prevent spurious video signals on the green channel from causing horizontal jitter. The output on pin 12 is averaged at C574 and used to disable the SOG white balance adjust control (VR 204).

9.3.7 HORIZONTAL FREQUENCY TO VOLTAGE CONVERSION

Positive sync from I501-6 is applied to I507-10. VR506 is used to set the output pulse at pin 5 to 12 usec. The output is then inverted and amplified at the collector of Q513 to a 20V pulse. Because the output pulse is constant and the input frequency is variable the ratio of output pulse to total period will be determined by the input frequency. In CGA mode the input period is 63.5 usec ([63.5 - 12]/63.5 = 0.81). In VGA mode the input period is 31.5 usec ([31.5 - 12]/31.5 = 0.62). This ratio is then averaged by R524 and C521 to produce a voltage proportional to frequency (20V * 0.8 = 16.2V, 20V * 0.62 = 12.4V).

9.3.8 HORIZONTAL DEFLECTION CONTROL

The voltage at R524/C521 is filtered by R574 and C559 before being applied to I506-5. I506 in this application is combined with Q516 to form a buffer. The voltage difference between the supply voltage (20V) and the voltage at the emitter of Q516 divided by R588 and VR502 determines the amount of current used to charge C548, the timing capacitor for the horizontal processor. If we assume that VR502 is set to midrange;

7.5k + 2.5k = 10k
3.8V/10k = 380uA (charge current in CGA mode)
7.6V/10k = 760uA (charge current in VGA mode)

20V - 16.2V = 3.8V.
20V - 12.4V = 7.6V

The total conversion process allows the horizontal processor (HA11235) to run at a frequency within the normal capture range of its phase locked loop (PLL). This guarantees that the monitor will lock in on any horizontal signal between 15kHz and 38kHz.

I401 (HA11235) is the deflection control IC. It has the following features:

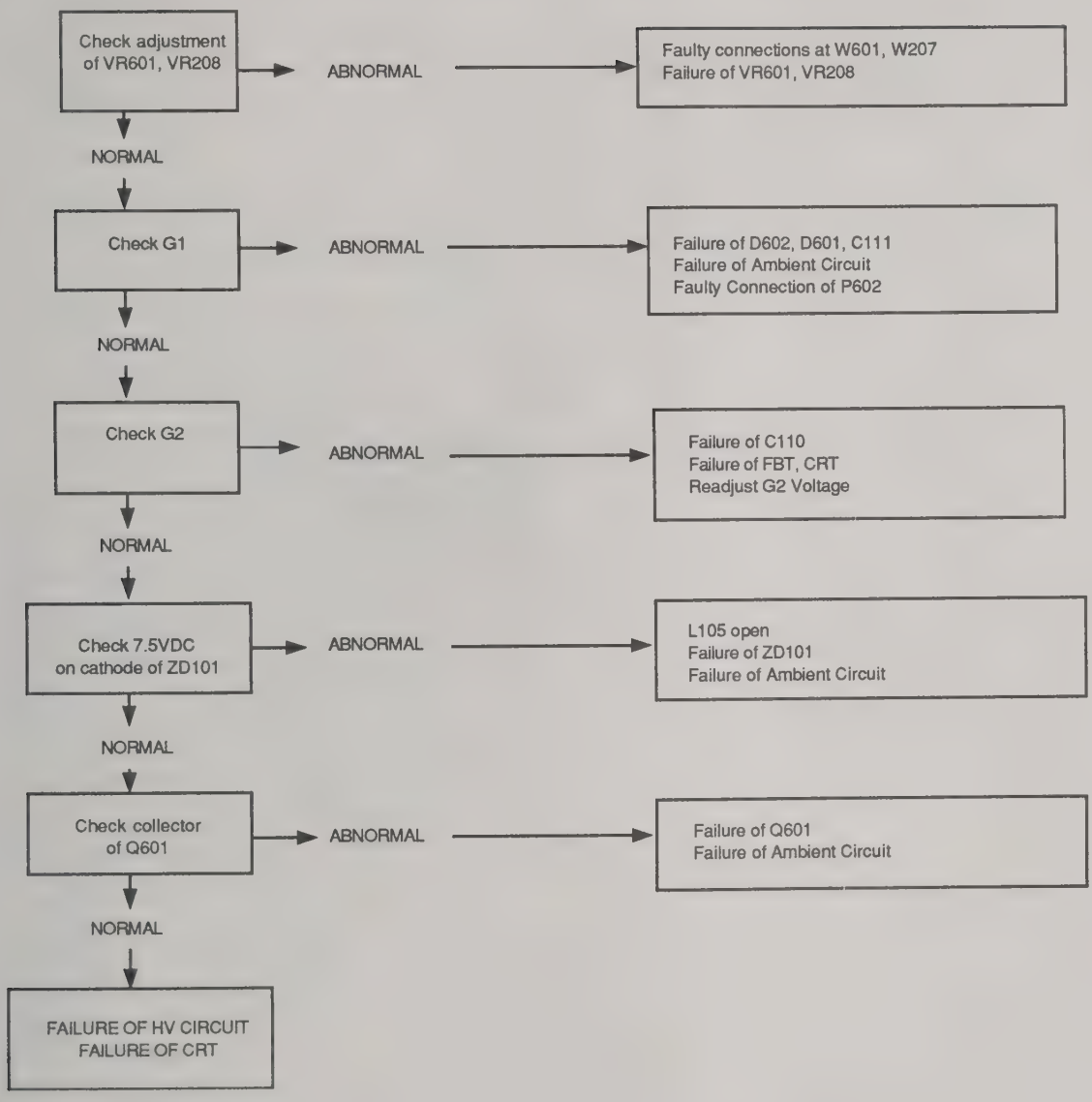
* Horizontal automatic frequency control (AFC)
* Horizontal oscillator
* Vertical oscillator
* Sync separator
* X-ray protect
* Vertical driver

PIN #	FUNCTION
1	Connected to capacitor to prevent parasitic oscillation.
2	Vertical output.
3	Feedback input for vertical DC/AC output voltage.
4	Connected to resistor to determine vertical oscillator discharge time constant.
5	Connected to capacitor to determine vertical oscillation frequency.
6	Vertical oscillator power supply.
7	Vertical sync input.
8	Sets vertical oscillation frequency.
9	X-ray protect input.
10	Horizontal drive output.
11	Horizontal oscillator power supply.
12	Connected to horizontal oscillator RC.
13	Phase detector flyback pulse input.
14	Phase detector output.
15	Sync separator video input.
16	Sync separator output.
17	Sync separator feedback.
18	Ground (GND)

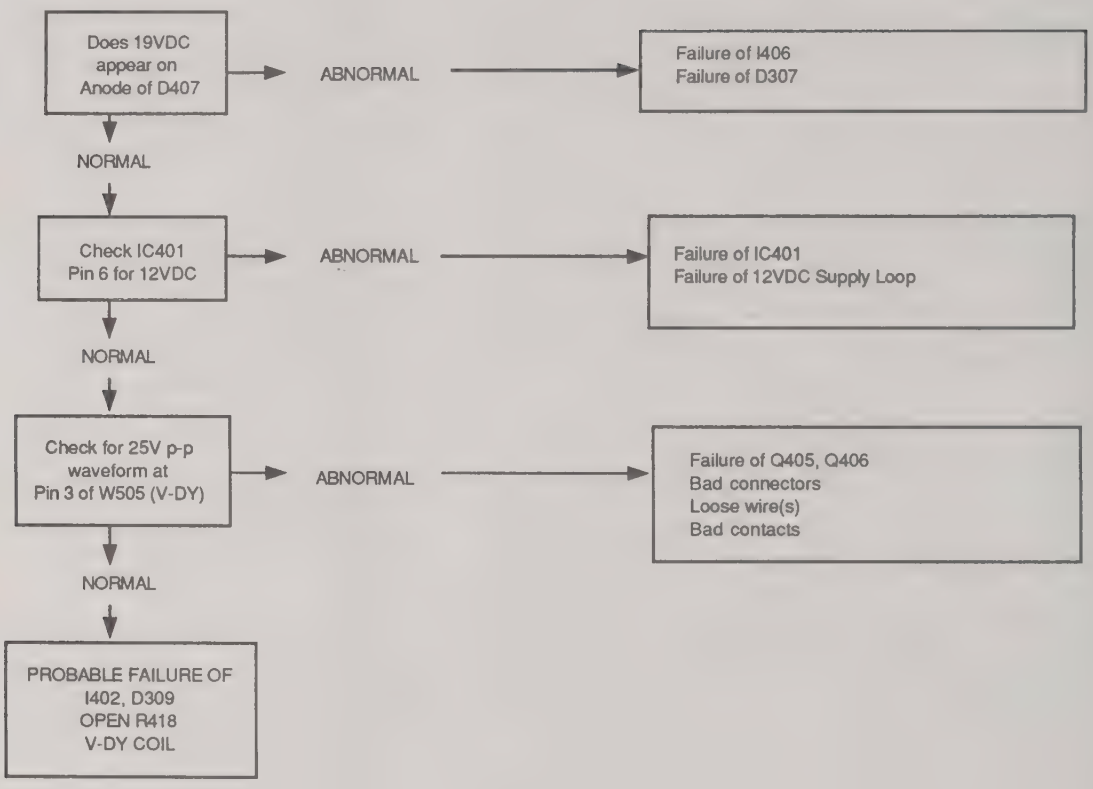
The monitor must lock in on a wide range of frequencies and process a variety of sync pulses. In order to maintain consistency in monitor performance with different adapter cards, the incoming sync pulse at I401-16 must be consistent. After the sync pulse is processed for the frequency to voltage converter, the output from I507-12 is applied to a second one-shot at I507-2. The output at I507-4 is a wider pulse to improve lock-in. This pulse is inverted and amplified at the collector of Q515 and applied to I401-16.

A feedback (AFC) pulse from pin 6 of flyback transformer T502 is used to close the phase lock loop. This pulse is applied to I508-9 via R554. D512 clamps the 50V - 60V pulse to 5.1V (ZD504). D513 clamps negative oscillations to 0.7V. VR507 (sub-horizontal position) controls the width of the output pulse at I508-12. This is an internal monitor setting. This control is preset at VGA-400 line mode to ensure that the external position control will allow the picture to be centered at all frequencies.

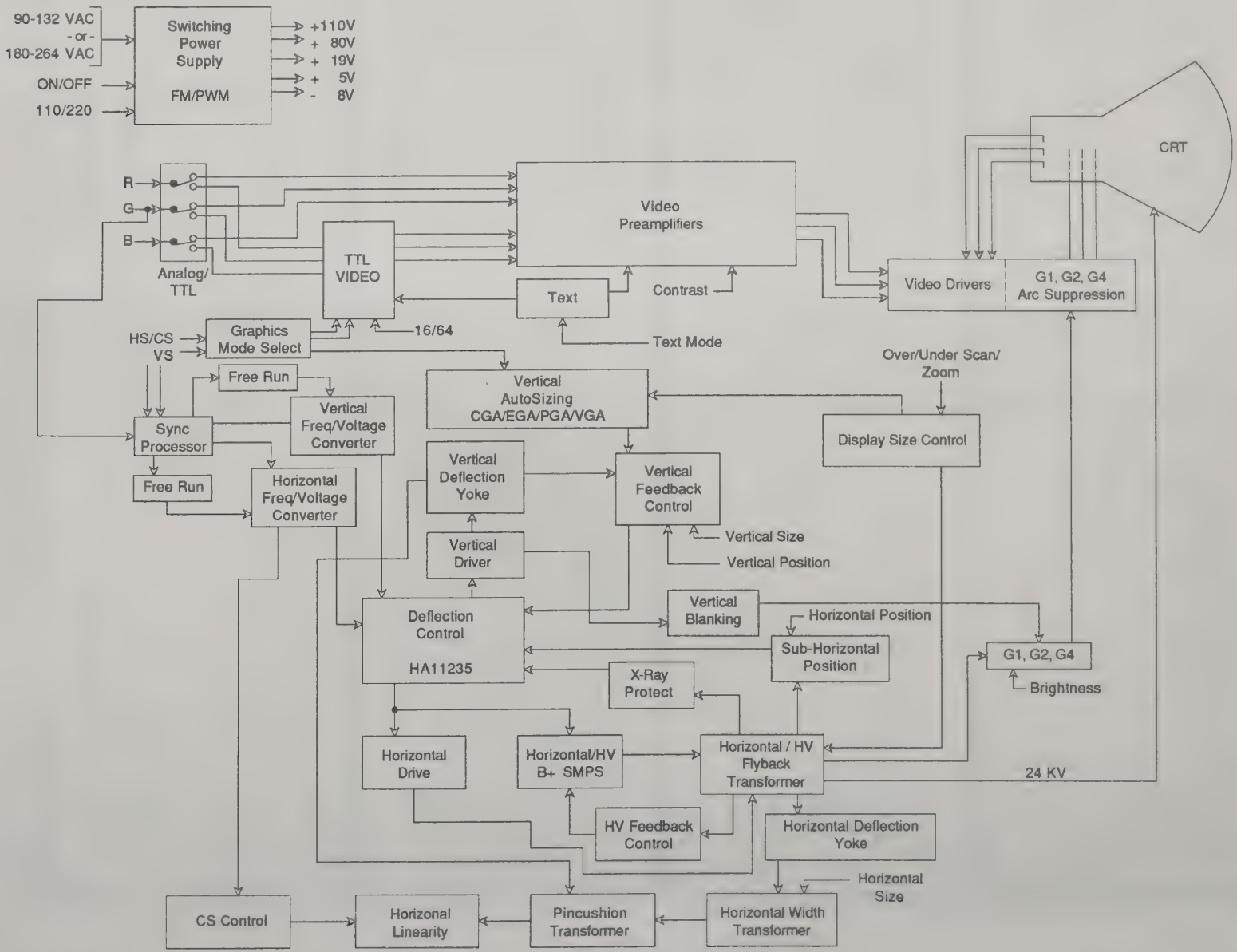
8.5 ABNORMAL SCREEN BRIGHTNESS



8.6 NO VERTICAL DEFLECTION

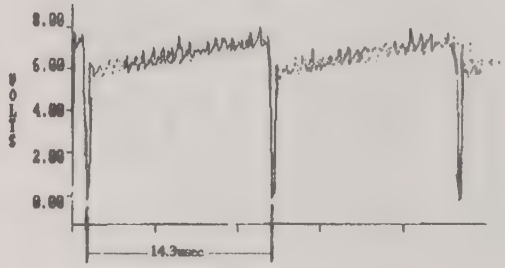


8.7 ULTRASYNC SERIES BLOCK DIAGRAM

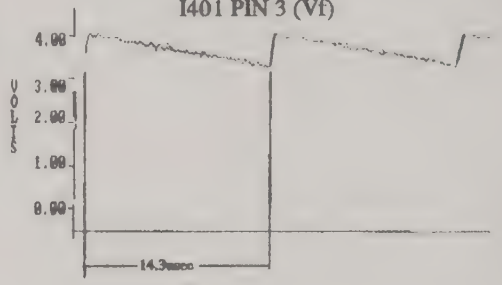


Critical Waveforms

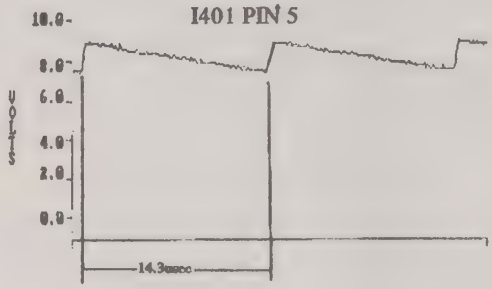
I401 PIN 2 (VO)



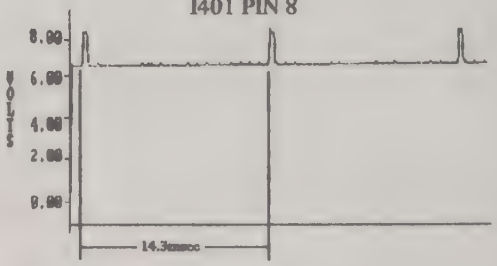
I401 PIN 3 (Vf)



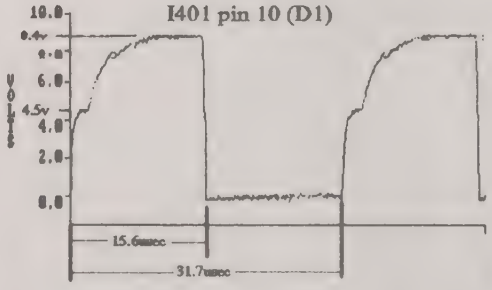
I401 PIN 5



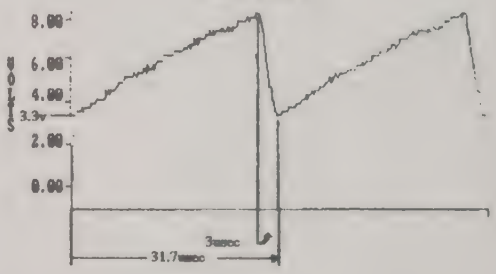
I401 PIN 8



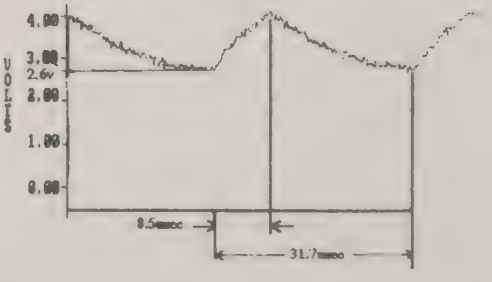
I401 pin 10 (D1)



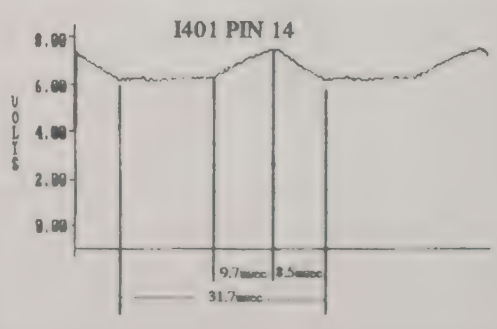
I401 PIN 12



I401 PIN 13



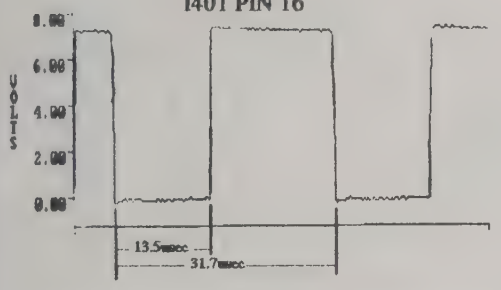
I401 PIN 14



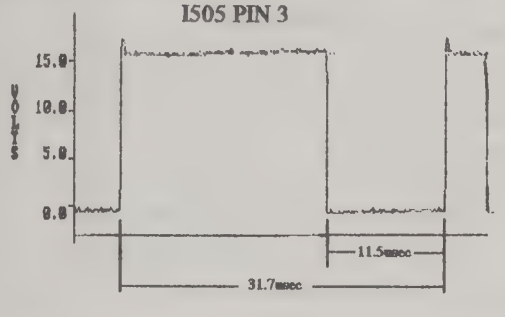
All waveforms measured using VGA signal timings

Critical Waveforms

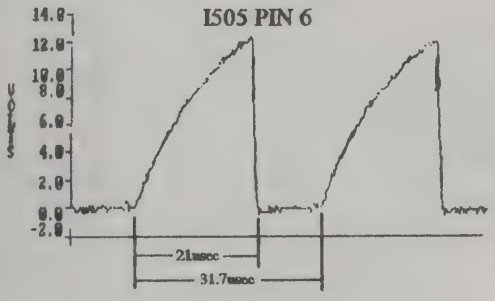
I401 PIN 16



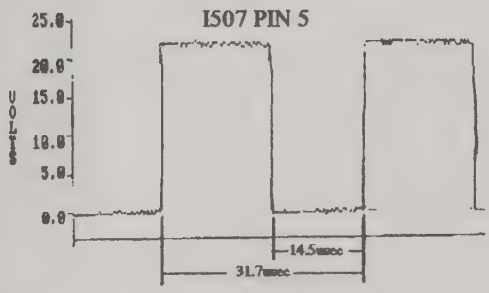
I505 PIN 3



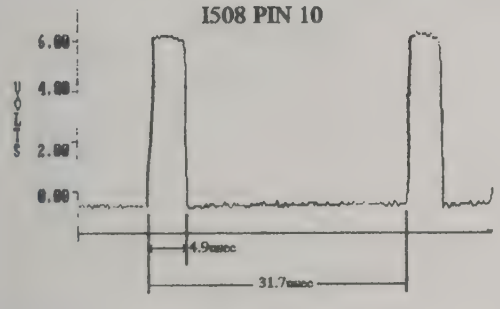
I505 PIN 6



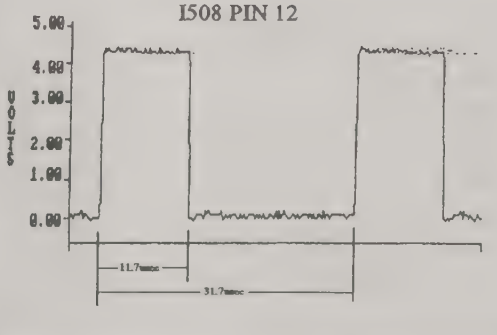
I507 PIN 5



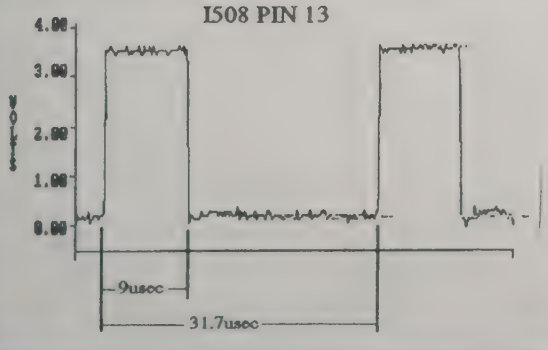
I508 PIN 10



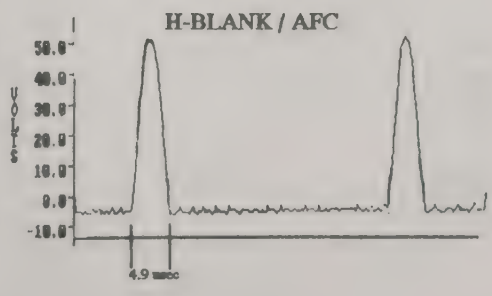
I508 PIN 12



I508 PIN 13



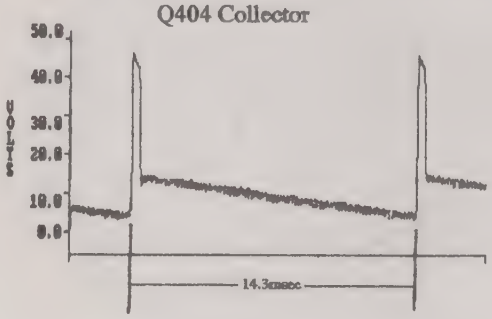
H-BLANK / AFC



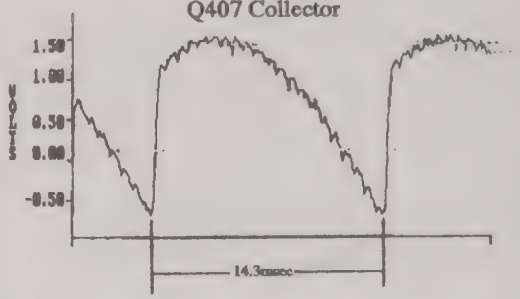
All waveforms measured using VGA signal timings

Critical Waveforms

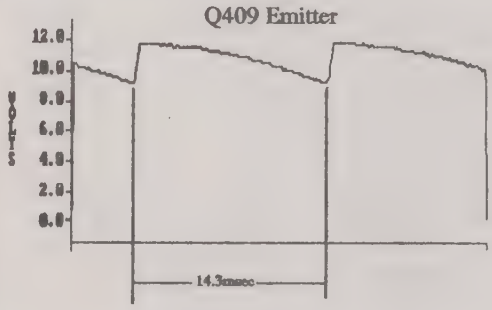
Q404 Collector



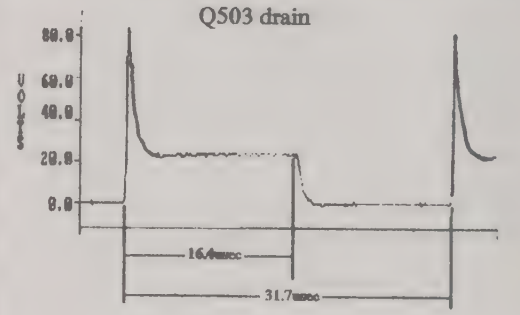
Q407 Collector



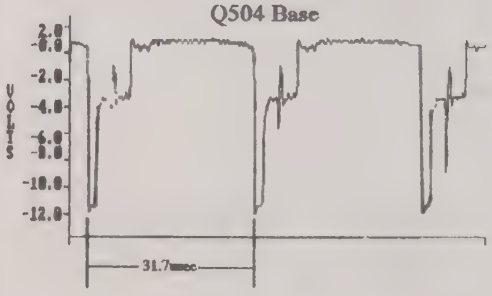
Q409 Emitter



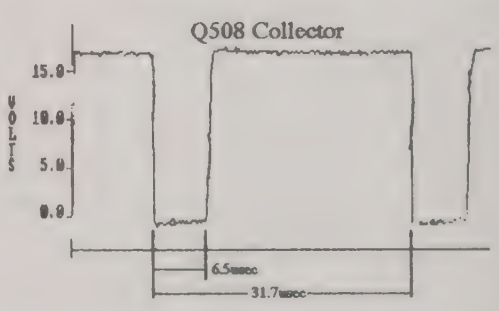
Q503 drain



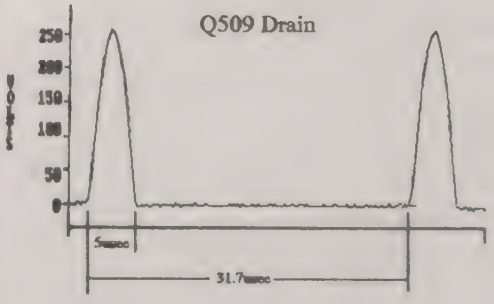
Q504 Base



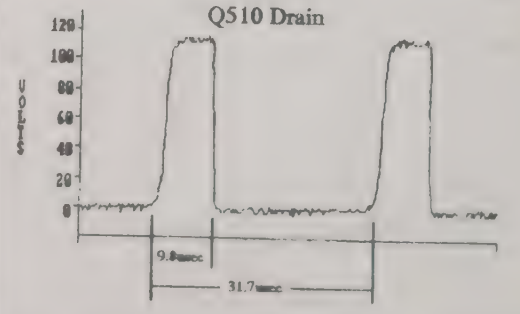
Q508 Collector



Q509 Drain



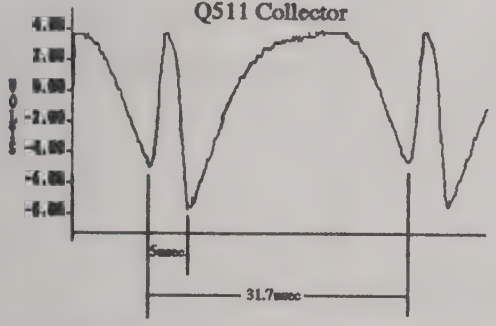
Q510 Drain



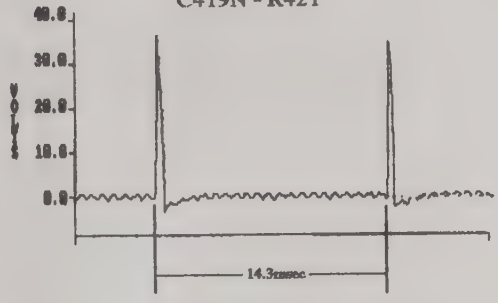
All waveforms measured using VGA signal timings

Critical Waveforms

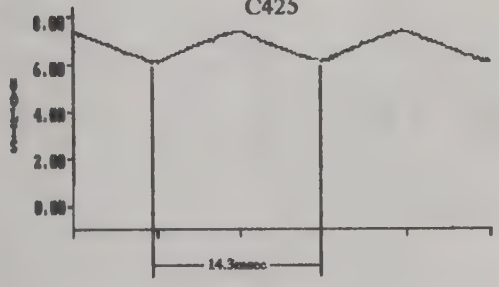
Q511 Collector



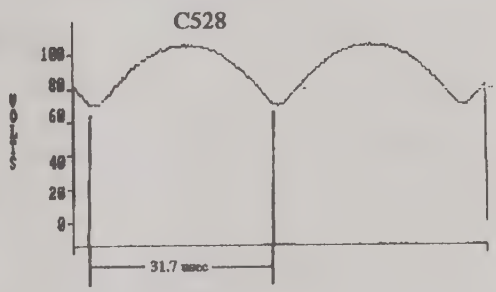
C419N - R421



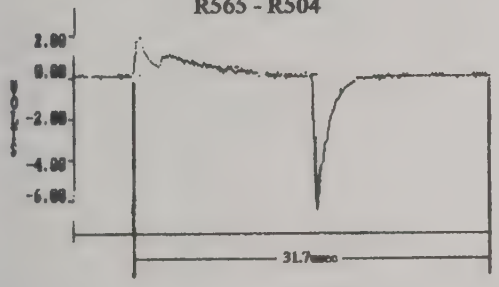
C425



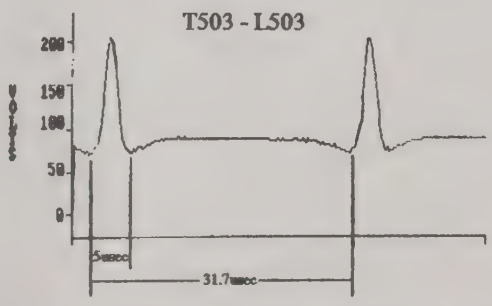
C528



R565 - R504

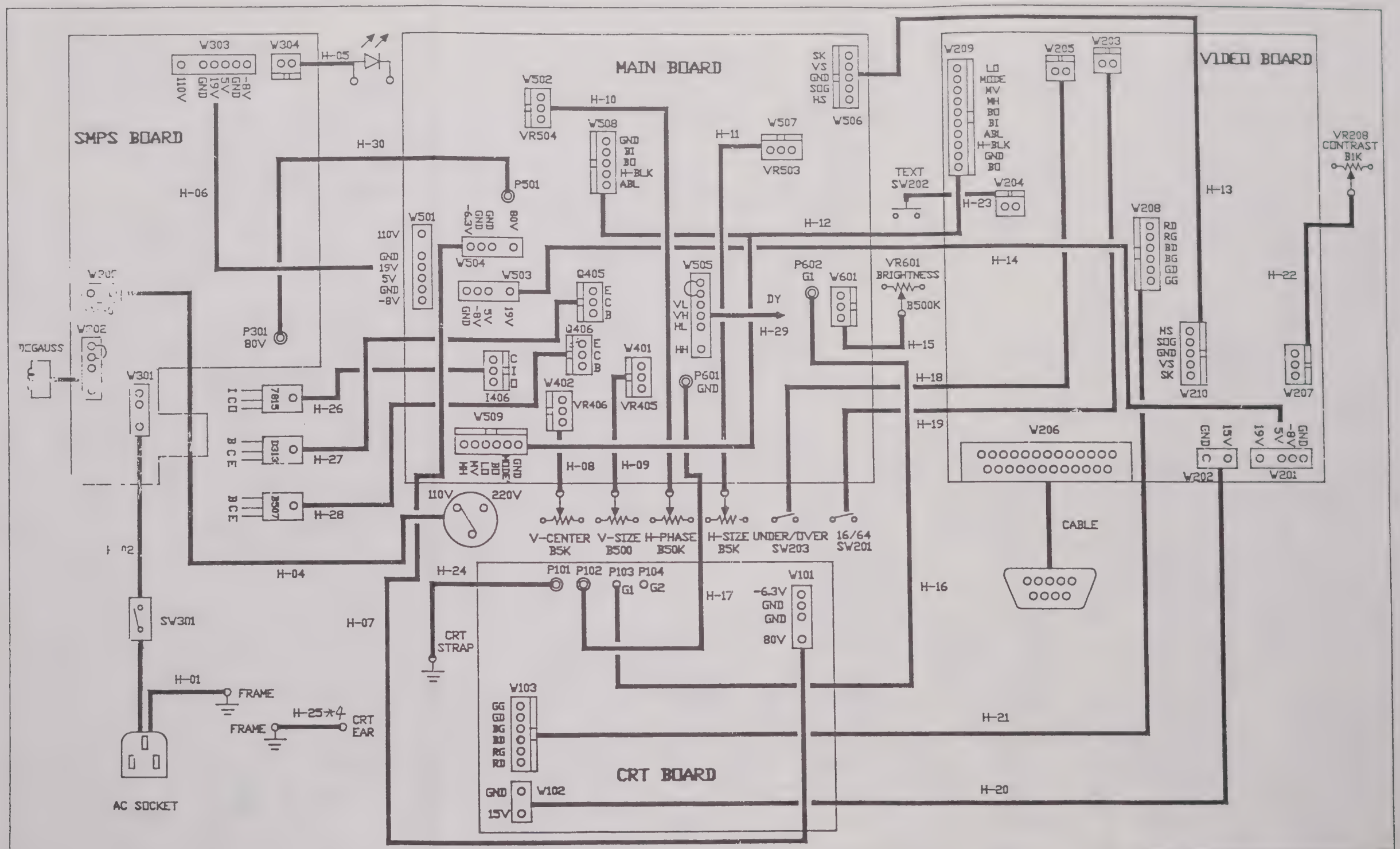


T503 - L503



All waveforms measured using VGA signal timings

NOTES



ULTRASYNC ULTRA 14 &16

HARNESSES LAYOUT DRAWING

PRINCETON®

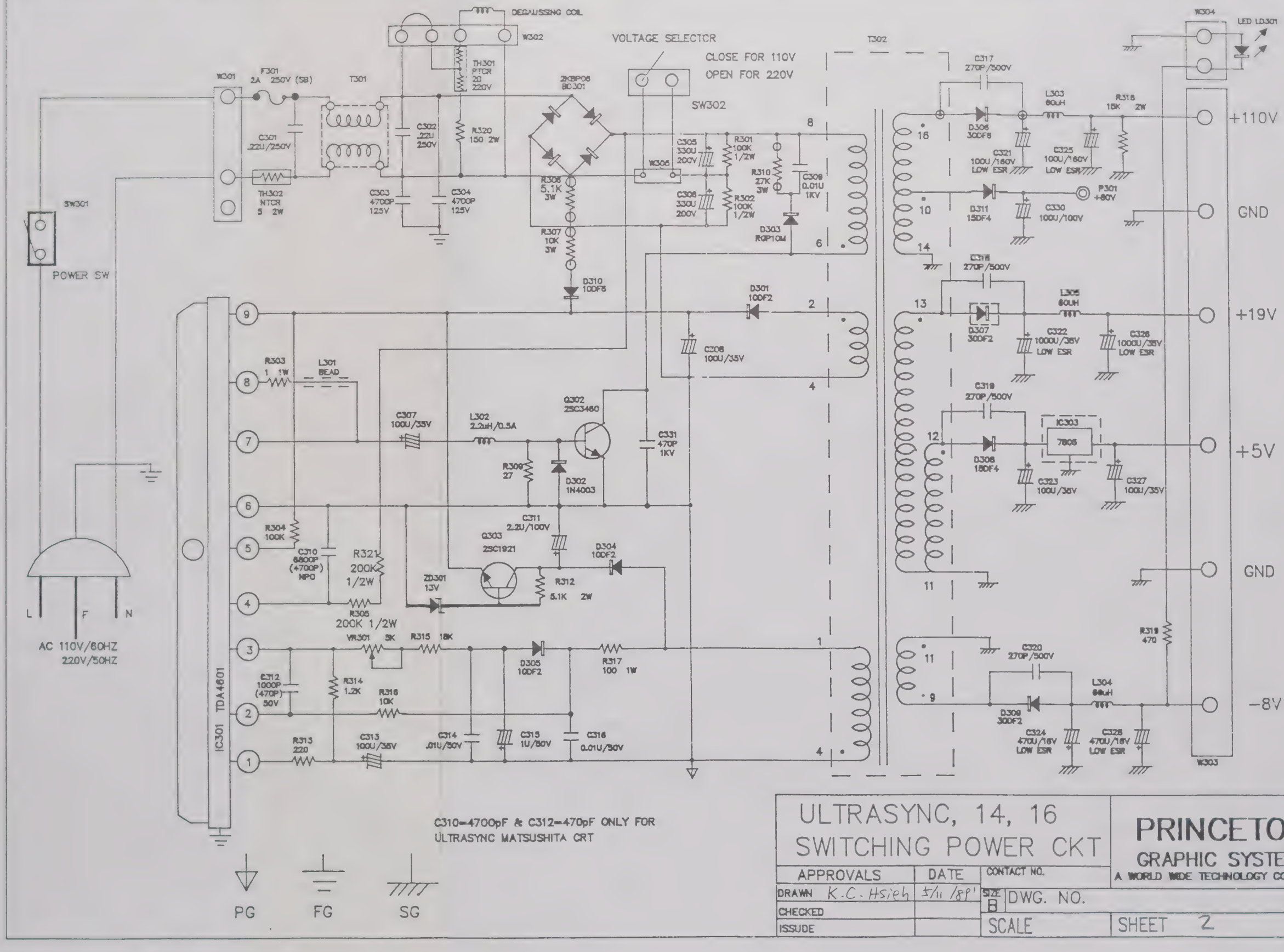
GRAPHIC SYSTEMS

A WORLD WIDE TECHNOLOGY COMPANY

APPROVALS	DATE	CONTACT NO.
DRAWN K.C.Hsieh	05/04/89'	
CHECKED		
ISSUDE		

SIZE B | DWG. NO. | REV. 1

SCALE | SHEET 1



C310=4700pF & C312=470pF ONLY FOR ULTRASYNC MATSUSHITA CRT

ULTRASYNC, 14, 16 SWITCHING POWER CKT

PRINCETON®
GRAPHIC SYSTEMS
A WORLD WIDE TECHNOLOGY COMPANY

APPROVALS	DATE	CONTACT NO.
DRAWN K.C. Hsieh	5/11/88'	SIZE B DWG. NO. REV.
CHECKED		SCALE SHEET 2
ISSUDE		

+110V
C504 47U 160V LOW ESR
C505 0.01U 500V
Q501 D1163A
Q502 B649A
D516 11DQ06
D517 11DQ06
D501 15DF4
L501 5mH
C506 100U 160V LOW ESR
C507 0.01U 500V
W505 6 5
T502
R502 150 1/2W
2.2 R592 1/2W
R503 8.2K 2W
R505 10 2W
+16V
C509 1000U 25V
R506 150 1/2W
C510 0.022U 50V PE
H-DRIVE
R509 2 2W
C511 10U 100V LOW ESR
T501
R510 0.5 2W
Q504 D1556
C512 6800P 1.6KV PP
W505 1 H-DY 2 H-LIN
D510 D511 RGP30M*2 FOR ULTRASYNC
T503
T504
P1 P2 P3 P4
L503
R511 270 1W
C515 180P 500V
L503 5UH ULTRASYNC 7UH ULTRA-14&16
L502 2mH
D504 1N4003
VR501 500 2W
D503 1N4003
H-CENTER
D1
C514 100U 25V
R508 4.7K
Q503 IRF530
D502
F4
Q509 IRF830
C513 CPP 0.022U 630V
C513=CPP 0.018U/630V FOR ULTRA-14 (HITACHI CRT)
R511=560 1/2W FOR ULTRA-16
SRP600K*2 IN SERIES FOR ULTRA-14 & ULTRA-16
D510 R582 1M 1/2W
R586 1M 1/2W
R583 1M 1/2W
R587 1M 1/2W
D511
R603=75K FOR ULTRA 16
R603= 68K FOR ULTRA 14 HITACHI 0.28mm CRT
R604=100K FOR ULTRA 16
R604=51K FOR ULTRA 14 HITACHI 0.28mm CRT
CRT ANODE CAP
D601 10DF4
R603 100K
C601 2.2U 250V
W601
V-BLK
C603 0.1U 250V MF
VR601 500K
R605 51K 1/2W
D602 10DF2
BRIGHTNESS
R604 200K
ZD601 100V 0.5W
G4 FOCUS
G2 TO P104
G1 P602
+16V
+110V
Q601 C945
R602 100K
ZD602 6.8V 1/2W
Q602 C945
R601 1.2K
C604 1U 50V
C605 4.7U 50V
R606 330K
D603
D604
R607 10K
C606 1000P 50V
ABL
D514 10DF2
C541 4.7U 100V
VR505 10K
ZD502 30V
H-BLK & AFC
R561 10K
X-RAY
FROM SMPS BOARD
+110V
GND
+19V
+5V
GND
-8V
W501
110V
GND
GND
-6.3V
W504
R581 2 2W
R580 0.5 1/2W
TO CRT BOARD
P501
+80V
GND
GND
-6.3V
Q517 C945
X-RAY
R579 1K
+16V
C565 0.1U 50V
R569 2K
R563 4.5K
R564 10K
VCC
R567 2K
R566 2K
R568 1K
4 RESET
7 DISCH
6 THRES
I505 NE555
3 OUT
GND 1
8 VCC
2 TRIG
C537 560P 50V
I509 TL431
K A R
C540 0.22U 50V PE
Q510 IRF830
R562 1K
C539 0.01U 50V PE
Q508 C945
R565 1K
R504 1K
C553 1000P 50V
TL431
C528 0.82U 250V PP
C527 0.47U 250V PP
D509 10DF2
C526 0.47U 250V PP
D508 10DF2
C525 0.33U 250V PP
D507 10DF2
C536 0.01U 50V
Q507 TIP122
C555 0.01U 50V
Q506 TIP122
C554 0.01U 50V
Q505 TIP122
F1
F2
F3
R577 150K
VR602 10K
HV-ADJ
R578 5.1K
TO VIDEO BOARD
+19V
+5V
-8V
GND
W503
BY CONNECTER
W505
P601
GND

ULTRASNYC, 14, 16
HORIZONTAL OUTPUT CKT

PRINCETON®
GRAPHIC SYSTEMS
A WORLD WIDE TECHNOLOGY COMPANY

APPROVALS	DATE	CONTACT NO.
DRAWN K.C.Hsieh	5/11/89'	
CHECKED		
ISSUDE		

SIZE B | DWG. NO. | REV.
SCALE | SHEET 3

+16V
C441 470U 25V
Q407 B649A
R432 4.3K
R431 240K
P1
TO PIN TRANSFORMER
C423 1000P 50V
R433 4.3K
Q408 C945
R434 560
C422 33U 50V
PIN-GAIN
VR407 1K
P2
C424 470U 25V
R430 24K
R435 100
VR408 100
R428 10
C421 33U 50V
PIN-PHASE
Vo
R414 330
I406
7815
+19V
C428 220U 25V
C430 220U 25V
+16V
D408
1N4148*2
D410
* R421=1.8K FOR ULTRASYNC MEC. CRT
D407 1N4003
+19V
C417 220U 25V
Q402 B649A
R422 150 1/2W
R423 100
-8V
R424 360 1/2W
V-BLK
R417 220 1/2W
Q405 D313
R416 10
R419 1 1/2W
C419 1U 50V
R421 4.7K (1.8K)
R420 1K
Q403 C945
C438 0.01U 50V
D406
Q406 B507
C418 680P 50V
Q404 C945
C440 680P 50V
C439 680P 50V
R415=220 0.5W FOR ULTRA 14 HITACHI CRT
R458 OPEN
R415 270
W505
V-DY
C435 0.1U 250V MF
R458 270
+16V
R556 4.3K
Q511 B649A
P3
TO H-SIZE TRANSFORMER
R559 240K
R560 68K
R557 4.3K
R555 1K
Q512 C945
D515
VR503 5K
H-SIZE
P4
R558 15 1/2W
C534 0.1U 50V
W507
R438 5.6K
R437 5.6K
VF
C414 33U 50V
R440 6.2K
C415 4700U 25V
+19V
V-SIZE
W401
VR405 500
R441 220
R425 82 1/2W
Q409 D1609
R426 510
V-POS
C426 0.1U 50V
Q410 B649A
VR406 5K
W402
R427 510
VR402 20K
V-LIN
C413 1U 50V
R436 270 (220)
R439 1.5 (2) 1W
C416 100U 25V NP
* R436=220 FOR ULTRA-16
* R439=2 FOR ULTRASYNC MEC. CRT
+16V
C433 0.1U 50V
I405
R445 1.5K
R446 1.2K
R449 750
+16V
MODE
R454 3.3K
BO
R453 3.3K
Q413 C945
A0
A1
I405 CD4052
+16V
C431 0.1U 50V
R443 1.5K
R444 6.2K
MV
MH
LO
A0
A1
E
I404 CD4052
VDD
Y0b
Y1b
Y2b
Y3b
Zb
R455 3.3K
+16V
TO W209
GND MODE BO LO MV MH
GND BI BO H-BLANK ABL
W509
W508
TO W210
SK VS GND SOG HS
W506

CD4052

E	A1	A0	Channel ON
L	L	L	Y0b-Zb
L	L	H	Y1b-Zb
L	H	L	Y2b-Zb
L	H	H	Y3b-Zb
H	x	x	ALL OFF

ULTRASYNC, 14, 16
VERTICAL OUTPUT CKT

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SIZE B | DWG. NO. | REV.
SCALE | SHEET 4

ULTRASYNC, 14, 16 V/H PROCESSING CKT

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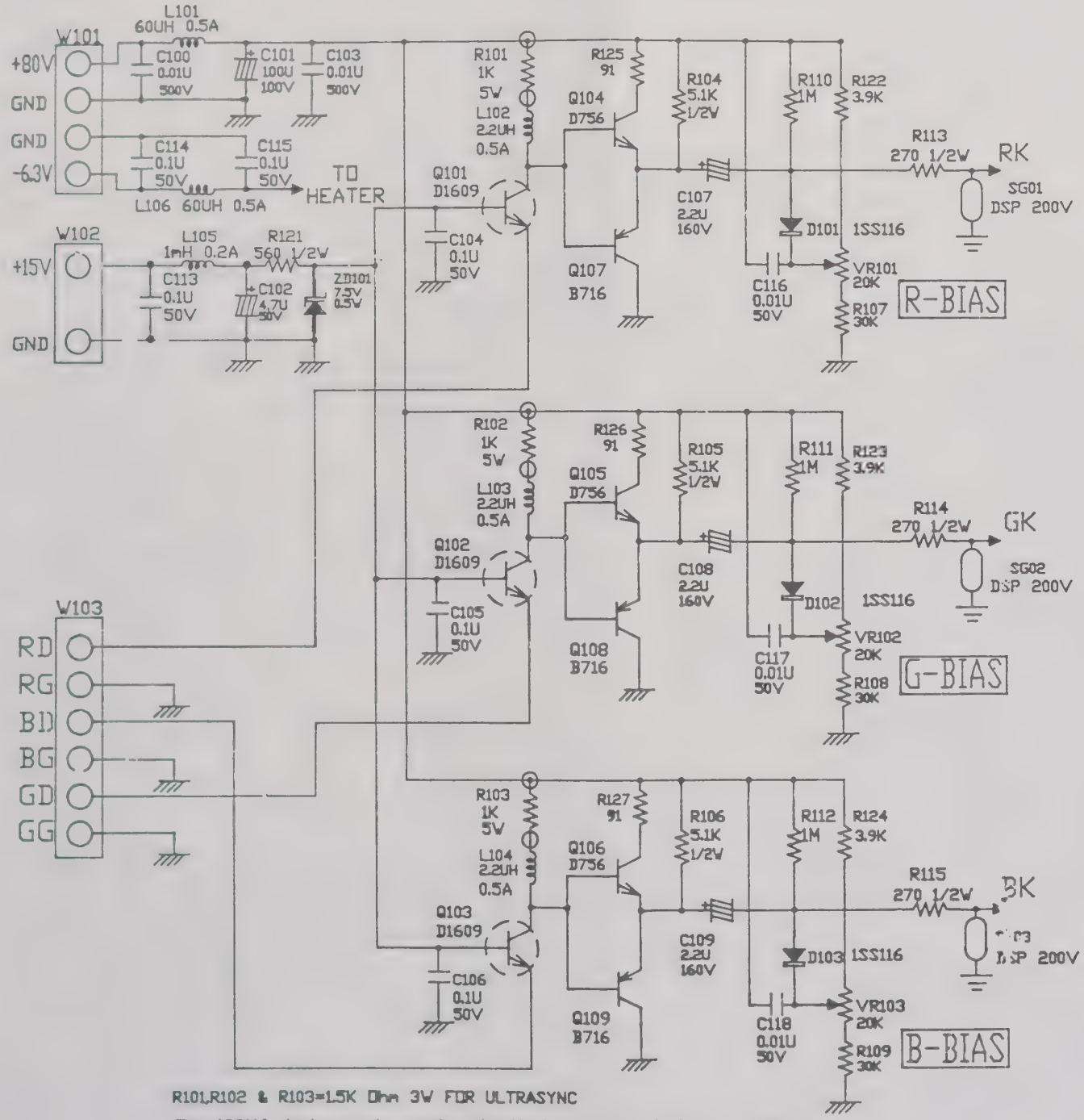
SIZE B | DWG. NO. | REV.

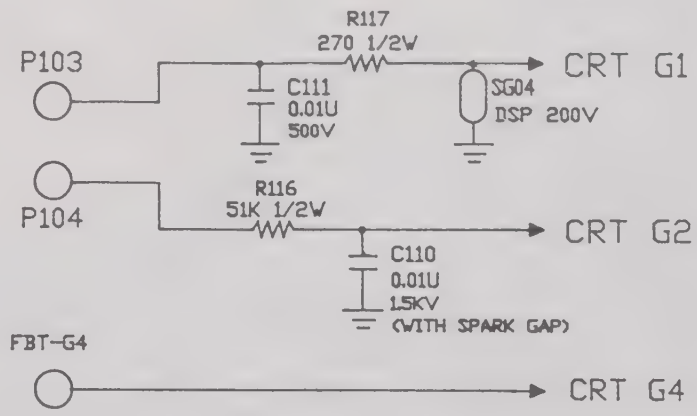
SCALE | SHEET 5

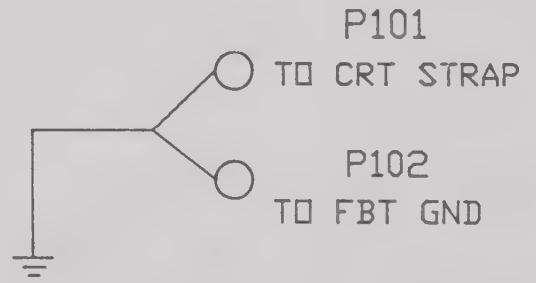
All diodes which are not indicated their descriptions are 1N4148



R101,R102 & R103=1.5K Ohm 3W FOR ULTRASYNC

One 1SS116 diode can be replaced with two 1N4448 diodes in series.





ULTRASYNC, 14, 16 CRT DRIVER CKT

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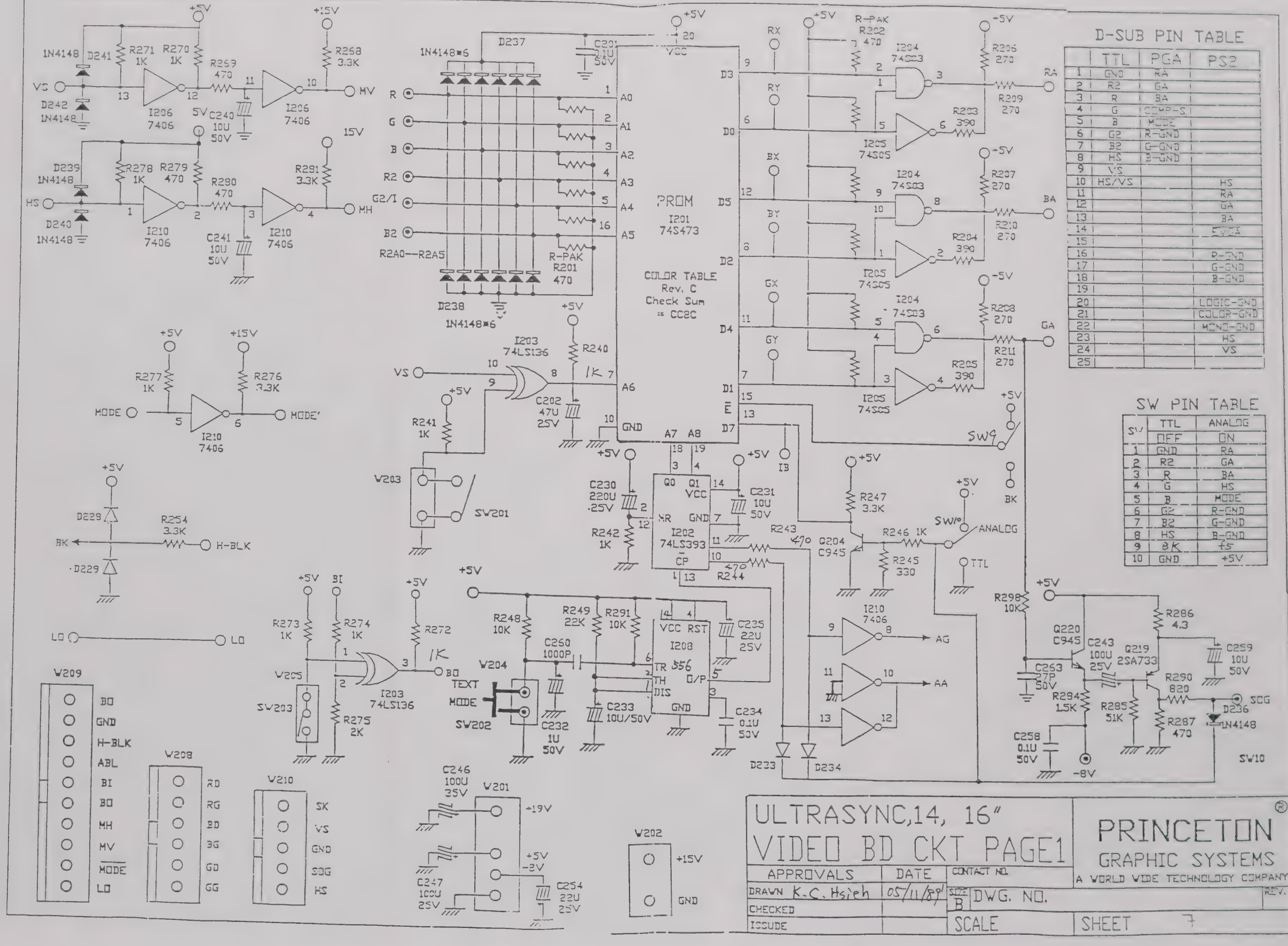
SIZE B | DWG. NO. | REV.

SCALE | SHEET 6



D-SUB PIN TABLE

	TTL	PGA	PS2
1	GND	RA	
2	R2	GA	
3	R	BA	
4	G	COMP-S	
5	B	MODE	
6	G2	R-GND	
7	B2	G-GND	
8	HS	B-GND	
9	VS		
10	HS/VS		HS
11			RA
12			GA
13			BA
14			SYNC
15			
16			R-GND
17			G-GND
18			B-GND
19			
20			LOGIC-GND
21			COLOR-GND
22			MONO-GND
23			HS
24			VS
25			

SW PIN TABLE

SW	TTL	ANALOG
	OFF	ON
1	GND	RA
2	R2	GA
3	R	BA
4	G	HS
5	B	MODE
6	G2	R-GND
7	B2	G-GND
8	HS	B-GND
9	BK	+5
10	GND	+5V

ULTRASYNC,14, 16"
VIDEO BD CKT PAGE1

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SCALE | SHEET 7

PRINCETON
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I209 7815 +19V +15V R282 51 1/2W C245 10U 50V ZD201 12V

I203 74LS136 I204 74S03 I205 74S05 I206 7406 I207 74S86 I210 7406 +5V 14

C248 0.1U 50V C249 0.1U 50V C250 0.1U 50V C251 0.1U 50V C252 0.1U 50V C253 0.1U 50V

CONT. SUB-CONT. -8V W207 VR208 1K VR209 10K VR205 10K VR206 10K VR207 10K

R259 33 R260 33 R261 33 R262 470K R263 470K R264 470K

R265 120K R266 120K R267 120K

C237 0.22U 50V C238 0.22U 50V C239 0.22U 50V

Q216 MPF4392 (2N5654) Q217 MPF4392 (2N5654) Q218 MPF4392 (2N5654)

RX RY BX BY GX GY IB

R256 470 R257 470 R258 470

I207 74S86 I205 74S05

D230 D231 D232

R231,232& 233 ARE JUMPER FOR ULTRA 14,16

R237,238& 239=47 FOR ULTRA 16

R292,293& 294 ARE JUMPER FOR ULTRASYNC

RA VR201 100 C206 100U 25V Q201 C945 R213 15K

R288 100 C209 0.1U 50V D201

R216 51 Q207 2N3906 R222 330 D204 D205 D206 C215 0.1U 50V R219 2K

+15V Q210 2N3904 R228 150 R225 330

BA VR202 100 C207 100U 25V Q202 C945 R214 15K

R289 100 C210 0.1U 50V D202

R217 51 Q208 2N3906 R223 330 D207 D208 D209 C216 0.1U 50V R220 2K

+15V Q211 2N3904 R229 150 R226 330

GA VR203 100 C208 100U 25V Q203 C945 R215 15K

R212 100 C211 0.1U 50V D203

R218 51 Q209 2N3906 R224 330 D210 D211 D212 C217 0.1U 50V R221 2K

+15V Q212 2N3904 R230 150 R227 330

VR204 20K

SK C242 0.1U 50V Q205 C945

ABL R253 100 C236 0.1U 50V Q206 2SA733

R252 10 R251 10 R250 10 D218 D217 D216

+15V R234 1K D219 D220 R292 22 D225 C224 0.1U 50V Q213 2N3904 R231 150 C221 100U 25V R237 91 (47) C227 82P AG

+15V R235 1K D221 D222 R293 22 D226 C225 0.1U 50V Q214 2N3904 R232 150 C222 100U 25V R238 91 (47) C228 82P AA

+15V R236 1K D223 D224 R294 22 D227 C226 0.1U 50V Q215 2N3904 R233 150 C223 100U 25V R239 91 (47) C229 22P

W208 RD RG BD BG GD GG

ULTRASYNC, 14, 16 VIDEO BD CKT PAGE2

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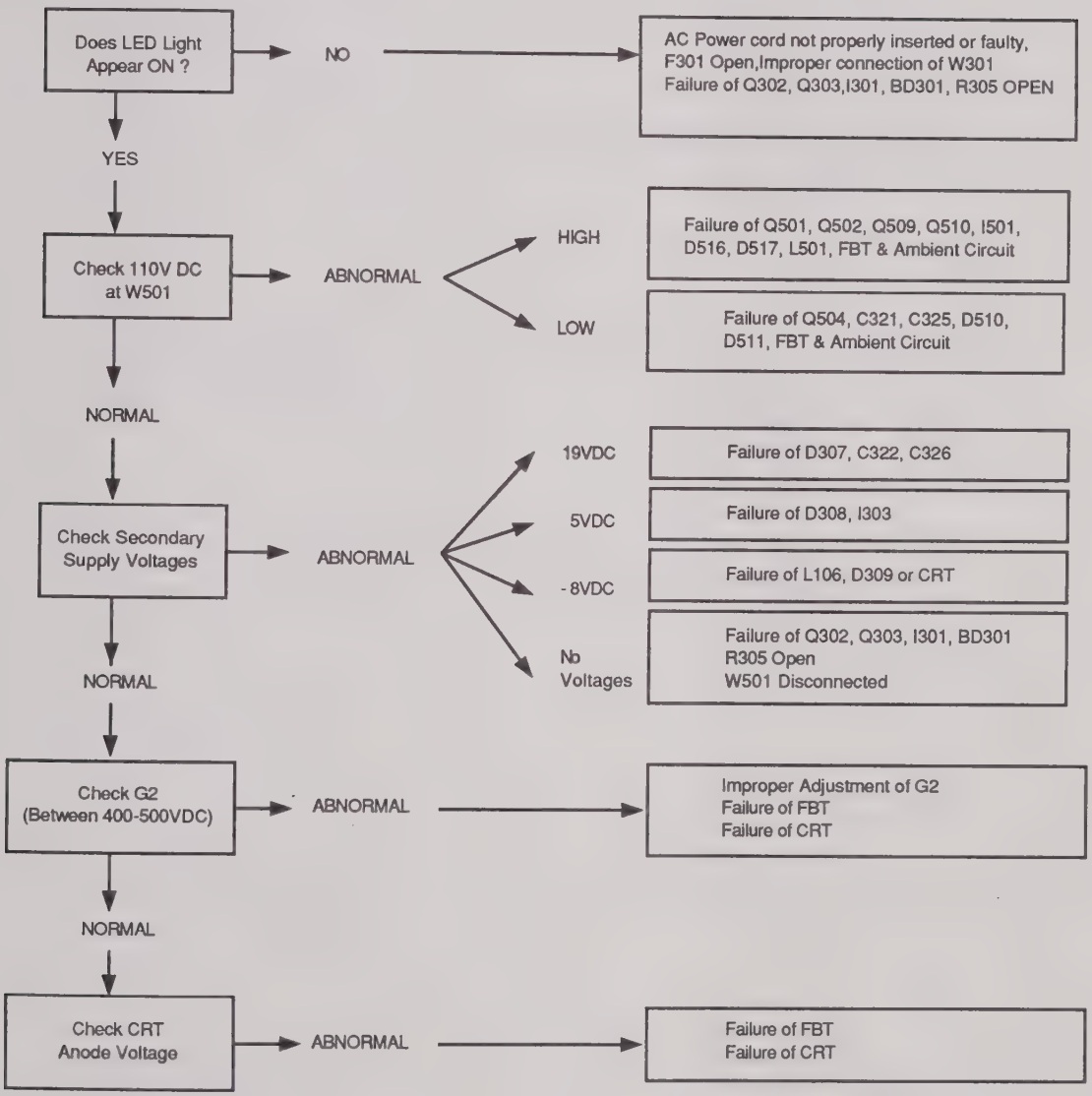
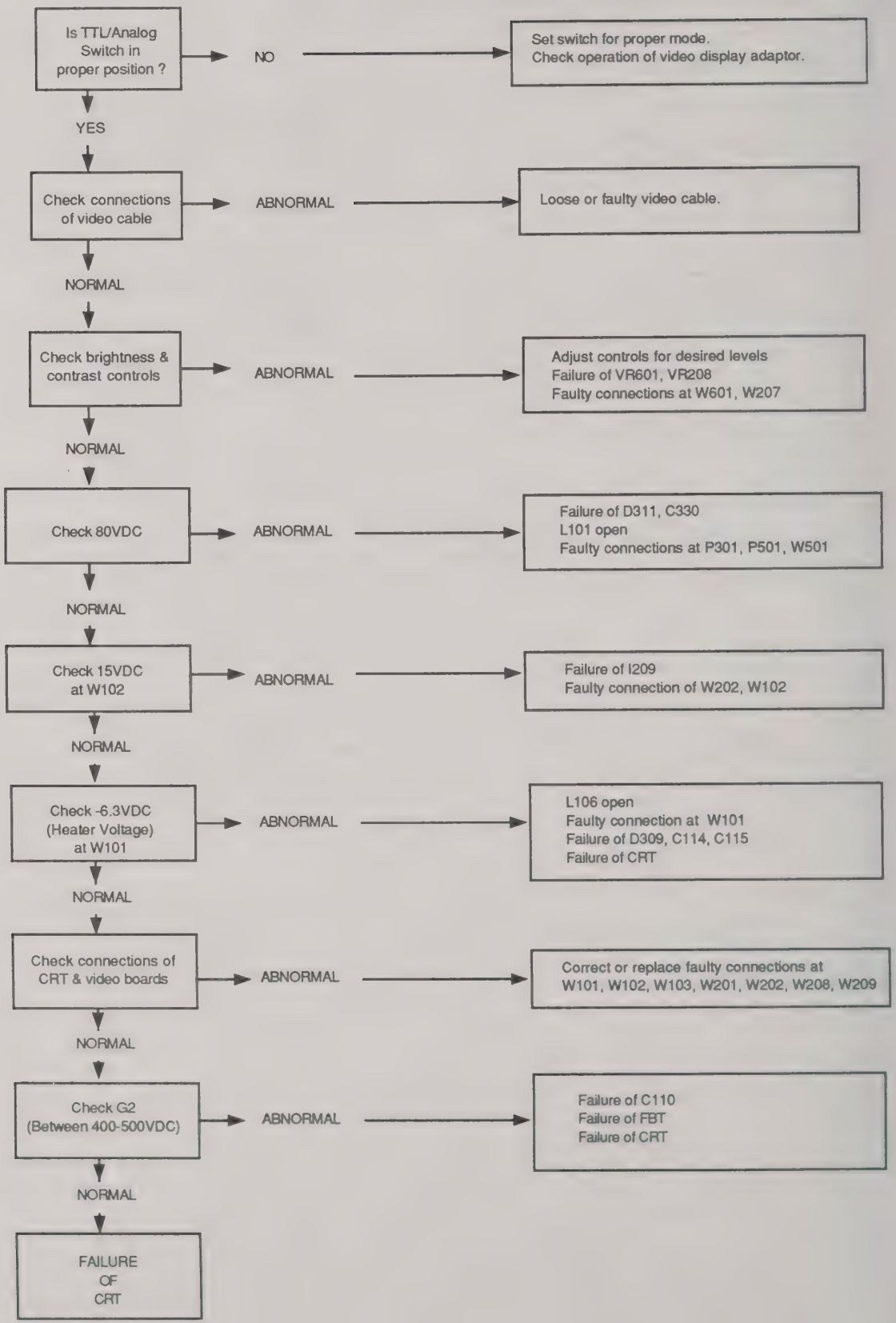
SCALE SHEET 8

8.0 TROUBLE SHOOTING FLOW CHARTS

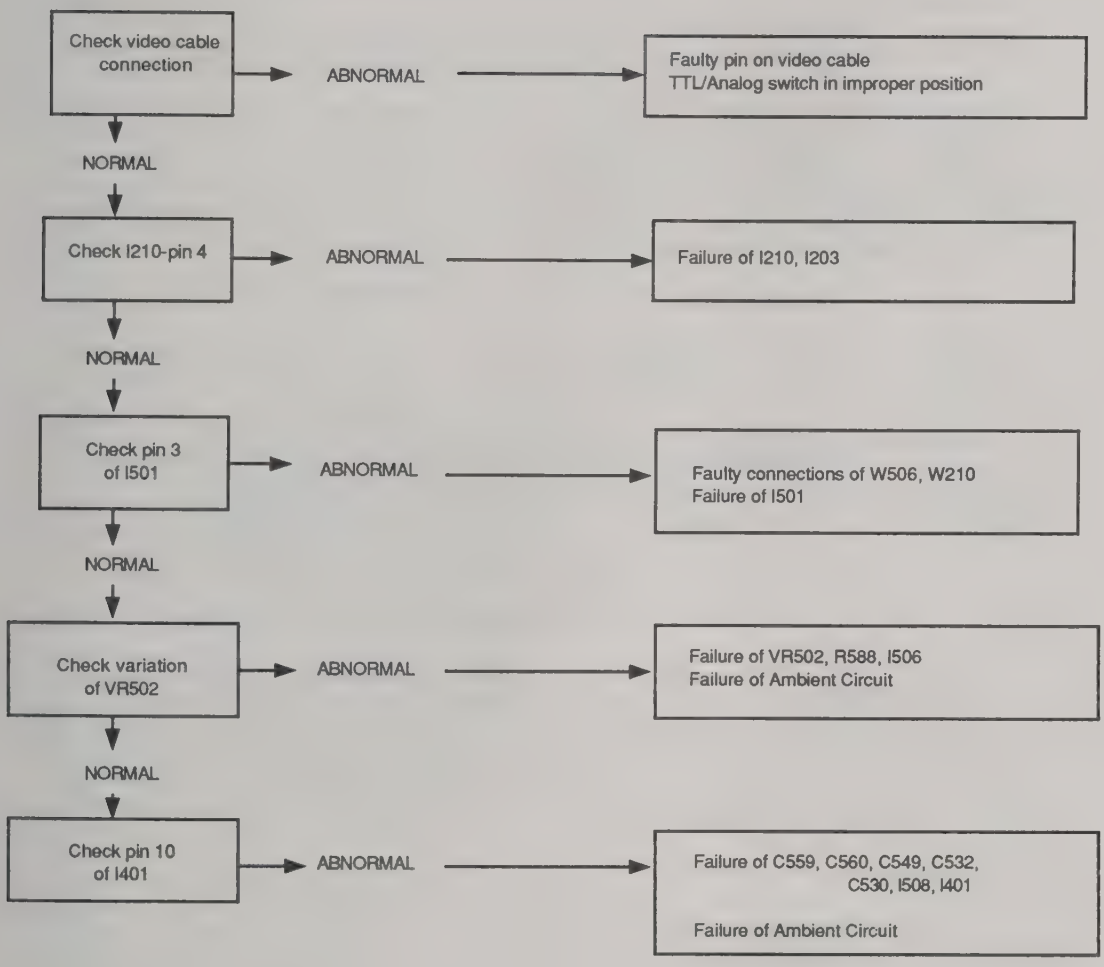
8.1 NO POWER or RASTER



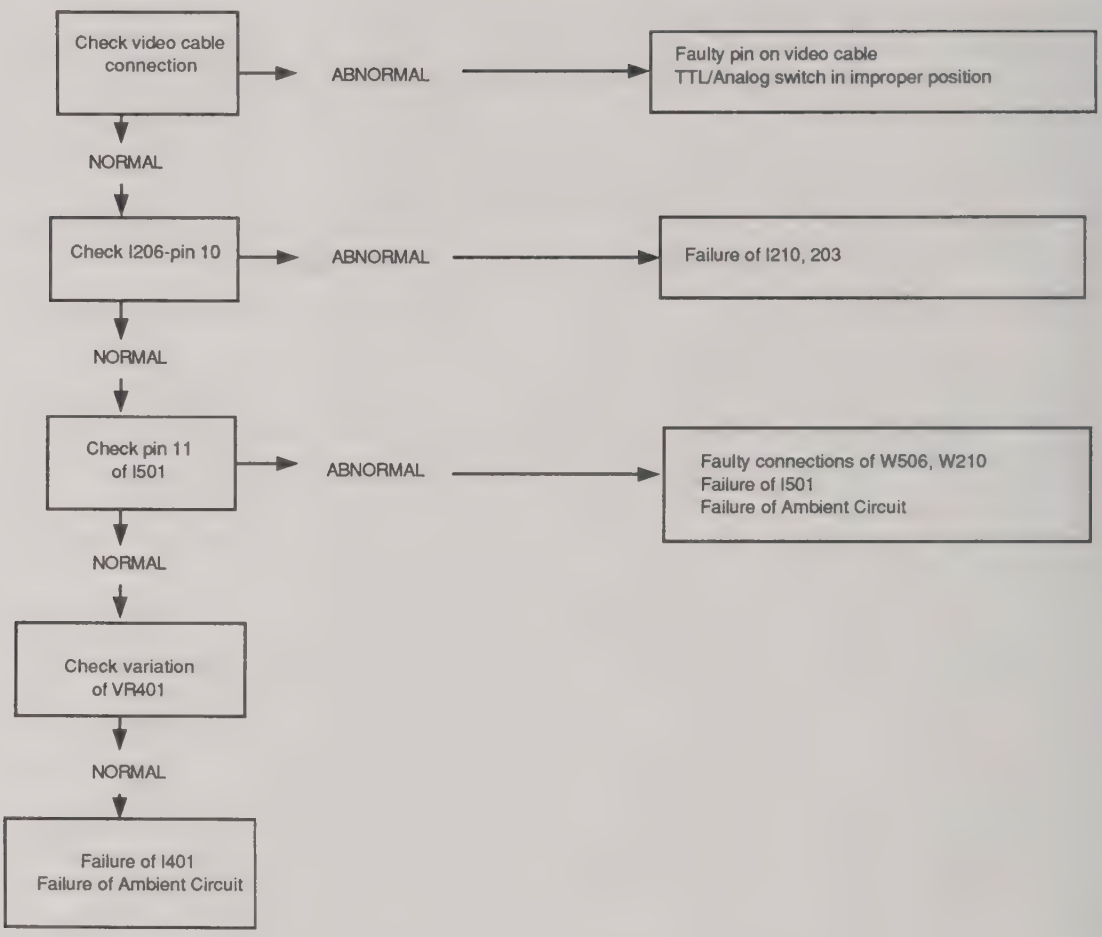
8.2 NO VIDEO


Is TTL/Analog Switch in proper position ?
NO
Set switch for proper mode.
Check operation of video display adaptor.
YES
Check connections of video cable
ABNORMAL
Loose or faulty video cable.
NORMAL
Check brightness & contrast controls
ABNORMAL
Adjust controls for desired levels
Failure of VR601, VR208
Faulty connections at W601, W207
NORMAL
Check 80VDC
ABNORMAL
Failure of D311, C330
L101 open
Faulty connections at P301, P501, W501
NORMAL
Check 15VDC at W102
ABNORMAL
Failure of I209
Faulty connection of W202, W102
NORMAL
Check -6.3VDC (Heater Voltage) at W101
ABNORMAL
L106 open
Faulty connection at W101
Failure of D309, C114, C115
Failure of CRT
NORMAL
Check connections of CRT & video boards
ABNORMAL
Correct or replace faulty connections at
W101, W102, W103, W201, W202, W208, W209
NORMAL
Check G2 (Between 400-500VDC)
ABNORMAL
Failure of C110
Failure of FBT
Failure of CRT
NORMAL
FAILURE OF CRT

8.3 UNSTABLE HORIZONTAL SYNC



8.4 UNSTABLE V. SYNC



The trailing edge of the processed AFC pulse is applied to I508-2. The output of this one-shot is a constant pulse width at I508-13. In order to improve on the capture range of the HA11235, this pulse is integrated by R551 and C549 and AC coupled to I401-13 via C532. Stability and gain of the horizontal PLL is controlled by C530, C531, R548, and R549.

9.3.9 HORIZONTAL FREE RUN FREQUENCY

In the absence of sync the voltage that determines the free running frequency (approximately 28 kHz - 30 kHz) is set by dividing the 20V to approximately 10V through R526 and R522 and applying the voltage to C521 via D506. Normally the cathode of D506 will be at about 20V and remain back biased. When sync is absent the output of I507-12 becomes logic "1". This turns on Q514, placing the collector in a logic "0" state. Operational amplifier I506 pins 1, 2, and 3 are being used as a comparator. When the voltage at pin 3 drops below the voltage at pin 2 (2V) the output at pin 1 becomes logic "0", activating the free run voltage circuit.

9.3.10 VERTICAL FREQUENCY TO VOLTAGE CONVERSION

Positive sync from I501-8 is applied to I502-2. The output pulse at I502-4 is a pulse with a width of approximately 7.8 msec. Pin 4 is the Q/ output of I502. The output is then inverted and amplified at the collector of Q411 to a 16V pulse. Because the output pulse is constant and the input frequency is variable the ratio of output pulse to total period will be determined by the input frequency. In CGA mode the input period is 16.7 msec (7.8/16.7 = 0.47). In PS2-400 line mode the input period is 14.3 msec (7.8/14.3 = 0.55). This ratio is then averaged with three stages of filtering (R405/C406, R409/C425, and R410/R411/C436). This was done because a single large filter caused the display to adjust very slowly when changing from one video mode to another. The voltage at C425 will be proportional to frequency (16V * 0.47 = 7.52V, 16V * 0.55 = 8.8V). This voltage is divided down to 2.2V and 2.6V respectively by R410 and R411. This voltage is applied to I402-5.

9.3.11 VERTICAL FREE RUN FREQUENCY

The monitor will lock in on any vertical frequency between 45 Hz and 120 Hz. Unlike the horizontal free run circuit, the vertical free run circuit was simplified and as a result must be set below the normal operating frequency range to prevent it from interfering with normal monitor operation. Resistors R442 and R448 divide the 16V supply to 4.22V. Diode D401 drops this voltage down to 3.52V and prevents this voltage from interfering with normal operation. Note that the low end of the monitor scan range is 45 Hz. This defines a period of 22.2 msec (7.8/22.2 = .35). This means the free run voltage at C425 will be 5.6V at 45 Hz. That is well above the free run voltage.

9.3.12 VERTICAL DEFLECTION CONTROL

I402, Q401, and R412 form a variable constant current source that is used to determine the discharge time constant. The voltage at I402-5 (which is a function of the vertical frequency) is compared to the voltage at R412. The voltage at R412 divided by R412 determines the discharge current.

The formula that governs this circuit is: I = C * dV/dT. dV is constant (approx. 1.5V), C = 2.2 uF, I = Vx/R412, where Vx is the voltage across R412.

I401-8 controls frequency by varying the voltage used to control the discharge current. This is normally set at mid-range. The loop is closed at I401-7. The vertical sync pulse at I501-8 is AC coupled to I401-7 via C407. D403 clamps negative excursions of the sync pulse to 0.7V.

I401-1,2,3 make up the vertical deflection control circuit. C411 and C412 prevent parasitic oscillation. I401-2 (VO) is the vertical output and I401-3 (VF) is the feedback signal from the output drive transistors.

9.3.13 CS-CONTROL

In addition to setting the frequency to voltage conversion for the horizontal PLL, VR506 (CS-ADJ) is also used in another frequency to voltage converter to determine the switching points of the S-shaping capacitors. The output of I507-12 is amplified and inverted by Q514 and averaged by R519 and C522. This voltage (TP401) is proportional to the horizontal frequency and is applied to three inverting inputs of comparator I504 (LM339). Resistor divider network R530 - R533 set the levels at which each comparator is turned off. The bottom comparator will trip at approximately 2.6V, the middle comparator at 3.7V, and the top comparator at 4.4V. These voltages correspond to switching frequencies of 17 kHz, 24 kHz, and 29 kHz respectively. Resistors R534, R535, and R536 provide hysteresis. This is necessary because voltages at TP401 near the trip levels of the comparator have enough ripple on them to cause the comparator to change state at random. In CGA mode the voltage at TP401 = 2.5V. The total S-shaping capacitance is C528 + C527 + C526 + C525. In EGA mode TP401 = 3.45V. The total S- shaping capacitance is C528 + C526 + C525. In VGA mode TP401 = 5V. The total S-shaping capacitance is C528.

9.3.14 AUTOMATIC CGA OVERSCAN

With the components used to display horizontal width in EGA and VGA modes, CGA timing would display a small screen. In order to correct screen size in CGA mode the logic of the over/underscan switch is reversed in CGA mode. When the button is in the normal scan position horizontal frequencies below 17 kHz are automatically overscanned. This is accomplished at I504-13 (BI). Below 17 khz BI is logic "1". Above 17 kHz BI is logic "0". This signal is applied to X-OR gate I203-1 to control the output logic due to changes in SW203. The "out" position of SW203 is considered normal scan. The "in" position is overscan. In CGA mode this logic reverses.

9.3.15 OVER/UNDERSCAN CIRCUIT

NORMAL SCAN

Assume that "BI" is logic "0" in EGA mode. For normal scan SW203 is in the out (open) position. The output of X-OR gate I203-3 is logic "1" (BO). "BO" is applied to comparator I504-6. The output of this comparator will be logic "0". Via R546 this signal becomes "F4". Q509 will be turned off and the value of the retrace capacitor will be the series combination of C512 and C513, approximately 5200 uF. "BO" is also applied to the base of Q413 via R453. The signal at the collector of Q413 will be logic "0" and applied to I405-9 (A1). When A1 and A0 are both logic "0" (A0 is only logic "1" in PGA-400 line mode) R446 is out of the circuit. R446 is the resistor that controls vertical overscan.

OVERSCAN

When SW203 is in the "in" position (closed) the output of X-OR gate I203-3 is logic "0" (BO). "BO" is applied to comparator I504-6. The output of this comparator will be logic "1". Via R546 this signal becomes "F4". Q509 will be turned on, shorting C513. The value of the retrace capacitor will be 6800 pf. In order to maintain the same amplitude pulse at the collector of Q504 (and thus the same high voltage) the deflection power supply will increase by approximately 8V. The increase in voltage will cause an increase in deflection current, causing the horizontal screen size to increase.

"BO" is also applied to the base of Q413 via R453. The signal at the collector of Q413 will be logic "1" and applied to I405-9 (A1). When A1 is logic "1" and A0 is logic "0" (A0 is only logic "1" in PGA-400 line mode) the lower half of R446 is shorted to ground. R446 is in series with R441, and the two resistors are in parallel with VR405 and R436, the resistors that control vertical size. The reduced resistance causes an increase in yoke current, causing the picture to increase in size in the vertical direction.

9.3.16 HORIZONTAL DEFLECTION/HIGH VOLTAGE

B+ SUPPLY

Maintaining constant high voltage and horizontal display size for the various video modes is accomplished primarily with the deflection B+ supply. I505 is an NE555 timer which, in this application, is being used as a power pulse width modulator (PWM). The power supply is being synchronized to the horizontal scan rate.

The horizontal drive pulse at I401-10 is differentiated by C553 and R504 and applied to the base of Q508 via R565. The positive portion of the trigger pulse is inverted and amplified at the collector of Q508. The NE555 triggers on the falling edge of the trigger pulse. The output pulse at I505-3 is applied to the gate of Q510 via R562. Q510 controls the switching of pass transistor Q501.

When Q510 is turned on it grounds R503. This drops the voltage at the base of Q502 2V below the emitter, turning on Q502. Q502 turns on Q501, with D516 and D517 ensuring that the base-emitter junction of Q501 will be properly forward biased on. The output of Q501-E is a 110V peak to peak square wave. D501 clamps negative transitions of the pulse to 0.7V. L501 and C506 average the pulse to a DC voltage proportional to the duty cycle of the pulse. The following table shows the output voltage at T502-1 vs video mode (+/- 5V).

MODE	T501-1
CGA	43V
EGA	55V
VGA	82V
MAC II	92V
8514/A	94V

The B+ supply powers the horizontal deflection and high voltage circuits. The retrace pulse at T502-10 is approximately 900V. This voltage is multiplied several times by the flyback transformer to produce an anode voltage of about 23.5 KV at the secondary of T502. There are two additional voltages created by T502: A -180V supply for brightness control, and a 50V supply for the X-ray protect circuit and feedback control for the PWM. The unrectified pulse (AFC) at T502-6 is used to close the phase locked loop of I401 and gets applied to the TTL PROM when the monitor is running in TTL mode.

BRIGHTNESS CONTROL

A -180V supply is created by rectifying and filtering the pulse (D601, C601) from T502-3. This voltage is used to power the brightness control circuit. R603, VR601, and R604 form a voltage divider. This voltage is applied to the tube G1 input on the CRT board via R605. At maximum negative voltage the screen will be black. A you approach 0 volts the display gets brighter. D602 prevents G1 from going positive by more than 0.7V. C603 AC couples the vertical blanking pulse to the brightness control. This pulse blanks the screen during vertical retrace. There is no horizontal blanking on the monitor.

HIGH VOLTAGE FEEDBACK CONTROL

The 50V supply is divided down through R577, VR602, and R578. The voltage at the wiper arm of VR602 will always try to set at 2.5V. I509 (TL431CLP) is the reference voltage source used to modulate the pulse. This voltage is applied to I505-5 to control the switching period of the PWM. For example, if the anode voltage is low, the feedback voltage will be low. This will cause the voltage at I509 to increase, increasing the on time of the output pulse. Increasing the on time of the output pulse will increase the output voltage at T502-1. This will increase the amplitude of the flyback pulse which will also increase the amplitude of the feedback pulse. This continues until the feedback voltage is large enough to divide down to 2.5V at the wiper arm of VR602.

AUTOMATIC BRIGHTNESS LIMITER (ABL) CIRCUIT

Anode current is sensed by converting it to a voltage. The current that would normally flow into ground is instead applied to ground through R601 at T502-7. As the current increases the voltage drop across R601 will increase. When the voltage across R601 reaches -0.6V (corresponds to an average beam current of 0.5 mA) Q601 will be turned on. This will cause Q601 to draw current, dropping the voltage at the cathode of ZD602 until it stops conducting. Q602 will turn off and the Q602-E will drop to 0V. In the video circuit Q206 will turn on, shorting the cathode of D216, D217, and D218 to ground. R250, R251, and R252 are now effectively inserted into the circuit in parallel with R222, R223, and R224, reducing the gain of the amplifier. The brightness of the display will be reduced. This feature is designed to protect the tube from being overdriven.

X-RAY PROTECTION

High voltage shut down in the event of a failure of the high voltage power supply is achieved by shutting down the horizontal processor's output (I401, pin 10). I401 provides the drive for the horizontal deflection/high voltage transistor.

Pin 9 of I401 is the x-ray protect input. Monitoring of excessive high voltage is achieved by monitoring the feedback winding of T502 (pin 6- 9). The voltage is rectified and filtered by D514 and C541 respectively. R722 and R561 divide the voltage down to a voltage that is less than 30 volts when the anode voltage is operating at 23 KV. When the anode voltage reaches or exceeds 28 KV the voltage across R561 will exceed 30 volts. This will cause ZD502 to conduct. This voltage is fed directly into pin 9 of I401. When the voltage at pin 9 reaches 0.6 volts, the internal crowbar circuit will shut down the horizontal processor. Only recycling of power will reset the crowbar circuit. If the fault still exists, the processor will immediately shut down.

Additional protection against excessive high voltage is provided by a feedback detect circuit. The feedback winding from the flyback is necessary for both high voltage regulation and operation of the x-ray protect circuit. If this voltage is not present when the unit is being powered up or this voltage drops out during operation D901 becomes forward biased. This will turn on Q900. The resulting voltage drop across R900, R901, and R902 will produce a voltage at pin 9 of I401 sufficient to activate the x-ray shut down of I401. If power is recycled the unit will not power up unless the fault condition is removed.

NOTE: On some early units high voltage shut down was achieved by shutting down the B+ PWM (I505). When the voltage at the cathode of ZD502 was sufficient to cause the diode to conduct this voltage was applied to the base of Q517. Q517-C would ground the reset pin (I505- 4), causing the B+ supply to shut down.

HORIZONTAL OUTPUT

There is already a great deal of literature written on the operation of horizontal deflection circuits. Because there is enough literature already available and extreme attention to detail is required, this section of the theory of operation will only identify the function of critical components.

The drive pulse from I401-10 is AC coupled to Q509-G. D502 provides a clamp for negative voltage spikes. R596 suppresses parasitic oscillations. R506 and C510 form a snubber to reduce switching losses in Q513. T501 is the drive transformer operating in a flyback mode. It is providing drive current to the horizontal output transistor Q504. R510 suppresses parasitic oscillation. R509 determines the charge voltage of C511 and controls the charge and decay time. C511 provides the negative voltage at turn off necessary to quickly remove stored charge from the base of Q504. The series combination of C512 and C513 (or just C512 when Q509 is turned on) is the retrace capacitor. D510 and D511 are the damper diodes. They are connected in series or in parallel, depending on the diodes used. The damper diodes provide a conduction path during the negative yoke current cycle. The horizontal output transistor conducts during the positive portion of the yoke current cycle.

9.3.17 HORIZONTAL DEFLECTION CURRENT CORRECTION

LINEARITY

L503 is the linearity coil. It will have a dominant effect on the left half of the screen. It is polarity sensitive and its inductance is frequency dependent.

The right half of the screen is primarily controlled by the S- capacitors, C525 - C528. The frequency of operation determines which capacitors are switched in (see CS ADJUST section).

WIDTH

T504 is a saturable reactor that controls the horizontal width. VR503 is used to control the amount of current available to Q512. When the wiper of VR503 is in its minimum position (ground), Q512 is turned off. This also keeps Q511 turned off. In this situation the effective load on the primary side of T504 is 1K ohm. As VR503 is increased, D515 shunts less current from the base of Q512. As Q512 turns on, the voltage at the base of Q511 drops and Q511 begins to conduct. The current passes through the primary of T504. This reduces the inductance of the secondary winding. The change in screen size is governed by the formula: E = L * dI/dT, where E is the B+ voltage, L is the total inductance of the yoke, pincushion transformer, width transformer, and linearity coil, and dI/dT is the change in current vs time. For a fixed B+ voltage, reducing the inductance will cause the current to increase. This means that the yoke current (display size) to increase.

PINCUSHION

T503 is also a saturable reactor that is identical to T504 in design. It performs pincushion correction. This is accomplished by changing the inductance of T503 in a parabolic fashion. Note that Q407 and Q408 perform the same function as Q511 and Q512. The major difference is that the pincushion circuit is processing an AC waveform. The sawtooth waveform at R439/VR405 is applied to the pincushion circuit. VR407 provides gain control and VR408 provides phase control. The gain and phase corrected waveform is AC coupled to the base of Q408 via C422.

HORIZONTAL CENTERING

Phase shift of the horizontal raster (independent of video phase shift) is accomplished with D503, D504, VR501, and L502. This circuit has only an incremental effect on raster position.

9.3.18 VERTICAL SIZE CORRECTION (VIDEO MODES)

Vertical size correction for the various video modes is controlled by applying the proper logic signal to I404 and I405. These IC's are CMOS switches. The following truth table defines the conditions for vertical size correction of the various video modes:

MODE	RESISTOR	LO	MH	MV	BO	BI	MODE/
CGA	R446	0	0	0	0	1	0
EGA	R443	0	0	1	1	0	0
PGA-400	R445	1	1	1	1	0	1
PGA-480	NONE	1	1	1	1	0	0
PS/2-350	R443	0	0	1	1	0	0
PS/2-400	R444	0	1	0	1	0	0
PS/2-480	NONE	0	1	1	1	0	0
MAC II	NONE	1	0	0	1	0	0
PS/2-768	R446	0	0	0	1	0	0

The monitor will not perform auto size correction for any of the 800 x 600 modes.

FUNCTION LABELS:

LO LO is applied to I404-6. When I404-6 is low I404 is enabled. This allows the monitor to perform the necessary size correction for CGA and EGA mode.

MODE PGA operation requires a MODE input that is used to MODE/ distinguish operation between 400 and 480 line mode. MODE/ will be the inverted MODE signal. Mode is applied to I210-5 and inverted at I210-6. This signal is applied to I405-10 (A0). In normal scan MODE/=0 will ground I405-5, placing R445 and R441 in parallel with the vertical size control resistors. This sets the vertical size in PGA-400 line mode. When MODE/=1, the monitor is set to PGA-480 line mode and I405 does not control vertical size.

MH Positive going TTL sync gets decoded into logic "0" and negative going sync gets decoded into logic"1". When combined with MV the monitor determines the proper vertical display size.

MV Positive going TTL sync gets decoded into logic "0" and negative going sync gets decoded into logic "1". When combined with MH the monitor determines the proper vertical display size.

BO In all modes but CGA (and any nonstandard mode running below 17 kHz horizontal frequency) a logic "1" is defined as normal scan and logic "0" is defined as overscan.

BI In CGA mode (and any nonstandard mode running below 17 kHz horizontal frequency) this function is at logic "1". It reverses the logic of BO and puts the monitor in overscan mode.

9.3.19 SYNC ON GREEN (SOG)

A SOG video signal is generally a 1V peak to peak (pp) signal. Video is positive with a 0.7V amplitude. The composite sync signal is negative with an amplitude of -0.3V. The green video signal is first applied to a small filter (R598, C263). This filter prevents video noise during disk access from causing picture break up. The filtered video signal is then applied to the base of Q220. Q220 and R284 form an emitter follower circuit to prevent loading of the video signal into the video preamplifier. C243 and R285 form a differentiator with a very large time constant. This ensures that the video signal charges and remains at a voltage greater than the voltage at Q219 minus 0.7V during the active video interval. When the negative vertical and horizontal sync signals are differentiated they are very short duration pulses compared to the video. As a result the composite sync is inverted and amplified at the collector of Q219. After passing through R290 the signal becomes "SOG" and is applied to I501-5.

Some TTL adapter cards take a long time to initialize. When sync does not appear on the proper pins the monitor defaults to sync on green mode. Noise on the green video line during computer boot up get into the sync on green processing circuit and will cause the monitor to make a chirping noise. Diode D236 disables the SOG signal when the monitor is in TTL mode, preventing this from happening.

9.3.20 VERTICAL DEFLECTION

The sawtooth at I401-2 is applied to Q404 via R414. This signal is amplified and inverted at Q404-C. Q405 and Q406 form the vertical output drive stage. This stage provides the necessary power to drive the yoke. In order to quickly retrace the vertical deflection beam back to the top of the tube the voltage during retrace time must be boosted. The waveform on Q406-E is a sawtooth with a 38V retrace pulse. Normally this pulse would be 19V. The pulse gets differentiated by C419 and R420 to remove the sawtooth portion of the waveform and applied to the base of Q403 via R421. The signal at Q403-C is an inverted and amplified (19V) blanking pulse. This signal is applied to the brightness control circuit to perform vertical blanking, but also is applied to Q402-B, turning the transistor on. D407 and C417 complete the voltage doubler circuit. Q402 turns on, inserting a 19V pulse on the 19V at the junction of C417 and D407. This doubling of the voltage occurs during every vertical retrace interval.

The output drive signal at Q406-E is used to create a DC supply via R437 and C414. This signal is reduced through R438 and summed with the reduced vertical sawtooth that originates at C415(-). This signal forms the signal to I401 necessary to close the feedback loop (VF). VR402 and C413 shape the wave to correct for nonlinearity in the scan.

9.3.21 VERTICAL POSITION

Vertical phase shift of the raster is achieved by adding removing DC bias current to and from the yoke current. When VR406 is at the low end of the control, Q410 is turned on and current is drawn through R425 to ground. This causes the raster to move toward the bottom of the tube. When VR406 is at the high end of the control, Q409 is turned on and current added to the yoke current through R425. This causes the raster to move toward the top of the tube.

9.4 VIDEO BOARD

9.4.1 VIDEO PREAMPLIFIER

ANALOG VIDEO

There are three video channels; red, green, and blue. Only the red section will be analyzed. The green and blue perform in the same manner.

A video signal of approximately 0.7V is applied to VR201. This signal is AC coupled to the next stage by C206. At the next stage the video signal is added to an 11V DC signal via R288 and D201. The new signal is applied to a buffer (Q201, R213). The buffered video is applied to a common-base amplifier (Q207, R216, R219, C215, R222) with a voltage gain of about 7. The output at the collector of Q207 is a video signal that has a reduced DC component (approximately 1.5V) and an AC component that is about 7 times greater than the input signal to the amplifier. This signal is applied to another buffer (Q210, R225). After the signal passes through R228, the contrast control and text mode interact with the circuit. The text mode signals are only applied to the red and blue video signals. When the text mode switch is cycled this point will be shorted to ground or opened, depending which mode the monitor is in.

CONTRAST CONTROL

The contrast control circuit (Q216, C237, R265, R262, R259, VR205) is operating as a voltage variable resistor. VR205 is an internal adjust level used to balance the three video channels. VR209 sets the range of the external contrast control VR208. By linearly controlling the gate voltage of Q216 the load that contrast circuit places on the video preamplifier is linearly adjusted from minimum (maximum contrast) to maximum (minimum contrast). In analog video modes Q216-S will always be grounded through I205-10.

9.4.2 TTL VIDEO

All TTL video signals must be processed and converted to an analog signal before being applied to the video preamplifier. In CGA mode there is an RGBI (red, green, blue, intensity) signal applied to a TTL PROM (I201). In EGA mode there is an R1, R2, G1, G2, B1, and B2 signal applied to the PROM. R711, DP1, and DP2 provide ESD protection.

(Red Video Only): CGA allows for the display of 16 colors. EGA allows for the display of 64 colors. The video signals that appear on I201-1 and I201-4 are processed by the PROM and appear at I201-9 (RX) and I201-10 (RY). R202 serves as a pull up resistor for all of the outputs.
RX is applied to I204-2. RY is applied to both I204-1 and I205-3. The outputs of these inputs is summed at

I204-3. R206, R203, R209, R280, and VR201 combine to divide the voltage down from TTL level (3.4V - 5V) to analog level (0V - 0.7V). In analog mode these resistors must combine to form an effective input impedance of about 75 ohms.

I201-13 (IB) is open in TTL mode, but is grounded in analog mode through Q204-C, disabling the PROM.

16/64 COLORS

There are some companies that developed EGA cards with non-IBM sync polarities. To the monitor these cards were CGA cards, and the PROM began processing video as if the card were CGA.

To prevent this from happening the vertical sync pulse (VS) is applied to an X-OR (I203-10). When SW201 is open and VS is positive, the output at I203-8 will average logic "0". If SW201 is closed the output at I203-8 will be logic "1". When a non-standard EGA mode is used it is still possible to get the correct colors by putting the 16/64 switch in the proper position.

TEXT MODE

Text mode allows the user to run the monitor in a monochrome mode. SW202 is a momentary switch. When the switch is applied it grounds one end of C260. This applies a negative trigger pulse to I208-2 (NE556 dual timer), initiating an output pulse on I208-3. This pulse is applied to pins 1 and 13 of I202.

I202 is a 74LS393, a dual binary counter. On each power up I202 is cleared by a momentary pulse from differentiator C230 and R242. Counter #1 has two inputs into I201-18 and I201-19. Counter #2 has inputs that are applied to I210 via R243 and R244. In analog mode the PROM inputs are disabled. The output of I210 is applied to the red and blue preamplifier circuit (AG, AA). Pulse #1 grounds the red video, producing a cyan text display. Pulse #2 grounds the blue video and restores the red, producing an amber text display. Pulse #3 grounds the red and blue video, producing a green text display. Pulse four returns the monitor to its initial state.

In TTL mode the cathode of D233, D234, and D236 are grounded through the analog/TTL switch. D233 and D234 disables the analog text mode switches. D236 disables the SOG signal. All text color mode control is TTL is controlled by the PROM.

TTL CONTRAST CONTROL

(Red video only): The RX and RY signals are applied to X-OR I207-12 and I207-13. The output at I207-11 is applied to inverter I205-11. The output level at I205-10 will be determined by the two incoming signals. For example, if only RX or RY are being displayed at a particular point in time on the display, I207-11 will be logic "1" and I205-10 will be logic "0". The contrast control will effect those colors. If both colors are being displayed (this is considered full intense color in EGA mode) I207-11 will be logic "0" and I205-10 will be logic "1". The contrast control will not effect this color.

9.5 CRT BOARD

9.5.1 VIDEO AMPLIFIER

The video signal is AC coupled to the video amplifier via C221. At this point a new DC level is set by dividing the 15V supply through R234, D219, D220, and R292. This signal is added to the video signal via D225 and applied to the base of a cascode amplifier. The lower portion of the cascode amplifier (Q213, C227, R237) is located on the video board. The upper stage is located on the CRT board.

The gain of the cascode amplifier is approximately R101/R237. The peak to peak output voltage at Q101-C will range from 30V on an Ultrasync to about 20V on an Ultra 16. The 7.5V supply at the base of Q101 sets the bias current of the amplifier. This supply level ensures good switching characteristics with minimum power dissipation.

In order to minimize the effect of stray capacitance and the capacitance of the tube a single ended push-pull buffer is employed (Q104, Q107). The capacitances associated with this circuit that effect switching speed are much lower than the tube and stray capacitances. R125 is added to prevent failure of Q101, Q104, or Q107 due to high voltage arcs from the tube.

This amplified and buffered video signal is AC coupled to the CRT bias control circuit through C107. This circuit sets the video black level. It also controls the color of the background raster. R122, R107, and VR101 divide the 80V supply down to the desired setting. This voltage is coupled to the video signal via D102. The voltage on the wiper arm of VR101 ranges from 45V - 74V. The black level should be set as close to 80V as proper color set up will allow.

The video signal is then applied to the red gun of the CRT via R113. SG01 is a spark gap designed to prevent tube arcs from damaging the video amplifier. The G1 input to the CRT has spark gap (SG04) protection as well as some series resistance and filtering (R117, C111). The G2 input to the CRT has a high voltage filter/spark gap (C110) and some series resistance (R116) to protect the CRT board from tube arcs.

9.5.2 HEATER VOLTAGE

The heater voltage originates on the power supply board. The -8V is dropped through R580 and R581 on the main board and applied to the CRT board. This voltage is filtered through C114, L106 and C115 before being applied to the tube.

10.0 ULTRASYNC, ULTRA14, ULTRA16 PARTS LIST

SPECIAL NOTE:
* DESIGNATES CRITICAL COMPONENTS OF X-RAY RADIATION.
⚠ DESIGNATES CRITICAL COMPONENTS OF SAFETY.

12 DENOTES ULTRASYNC PART ONLY
12& DENOTES ULTRASYNC WITH MATSUSHITA CRT ONLY
14 DENOTES ULTRA-14 PART ONLY
16 DENOTES ULTRA-16 PART ONLY

CRT BOARD

REF #	PART DESCRIPTION	ITEM #
C100	CAP CC 0.01UF 500V 20% Z5U	5-2104FZ
C101	CAP EC 100UF 100V 20%	5-2100CZ
C102	CAP EC 4.7UF 50V 20%	5-2472BZ
C103	CAP CC 0.01UF 500V 20% Z5U	5-2104FZ
C104	CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C105	CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C106	CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C107	CAP EC 2.2UF 160V 20%	5-2222DZ
C108	CAP EC 2.2UF 160V 20%	5-2222DZ
C109	CAP EC 2.2UF 160V 20%	5-2222DZ
C110	CAP CC 0.01UF 1.5K 20% Y5P	5-2104HY
C111	CAP CC 0.01UF 500V 20% Y5P	5-2104FZ
C113	CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C114	CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C115	CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C116	CAP CC 0.01UF 50V 20% Y5P	5-2104BZ
C117	CAP CC 0.01UF 50V 20% Y5P	5-2104BZ
C118	CAP CC 0.01UF 50V 20% Y5P	5-2104BZ
D101	DIODE RECTIFIER 1SS116	5-3116
D102	DIODE RECTIFIER 1SS116	5-3116
D103	DIODE RECTIFIER 1SS116	5-3116
L101	DRUM COIL 60UH 550MA	5-5600
L102	PEAKING COIL 2.2UH 90MA 15%	5-5022
L103	PEAKING COIL 2.2UH 90MA 15%	5-5022
L104	PEAKING COIL 2.2UH 90MA 15%	5-5022
L105	DRUM COIL 1MH 90MA 20%	5-5001
L106	DRUM COIL 60UH 550MA	5-5600
P101	2.36MM R PIN	5-0101P
P102	2.36MM R PIN	5-0101P
Q101	TRANS NPN 2SD1609C POWER	5-6609
Q102	TRANS NPN 2SD1609C POWER	5-6609
Q103	TRANS NPN 2SD1609C POWER	5-6609
Q104	TRANS NPN 2SD756A-D	5-6756
Q105	TRANS NPN 2SD756A-D	5-6756

Q106		TRANS NPN 2SD756A-D	5-6756
Q107		TRANS PNP 2SB716A	5-6716
Q108		TRANS PNP 2SB716A	5-6716
Q109		TRANS PNP 2SB716A	5-6716
R101	12	RES 1.5K MINI TYPE 5% 5W	5-1152I
R101	14	RES 1K MINI TYPE 5% 5W	5-1102I
R101	16	RES 1K MINI TYPE 5% 5W	5-1102I
R102	12	RES 1.5K MINI TYPE 5% 5W	5-1152I
R102	14	RES 1K MINI TYPE 5% 5W	5-1102I
R102	16	RES 1K MINI TYPE 5% 5W	5-1102I
R103	12	RES 1.5K MINI TYPE 5% 5W	5-1152I
R103	14	RES 1K MINI TYPE 5% 5W	5-1102I
R103	16	RES 1K MINI TYPE 5% 5W	5-1102I
R104		RES CF 5.1K 5% 1/2W	5-1512Z
R105		RES CF 5.1K 5% 1/2W	5-1512Z
R106		RES CF 5.1K 5% 1/2W	5-1512Z
R107		RES CF 30K 5% 1/4W	5-1303
R108		RES CF 30K 5% 1/4W	5-1303
R109		RES CF 30K 5% 1/4W	5-1303
R110		RES CF 1M 5% 1/4W	5-1105
R111		RES CF 1M 5% 1/4W	5-1105
R112		RES CF 1M 5% 1/4W	5-1105
R113		RES CF 270 OHM 5% 1/2W	5-1271Z
R114		RES CF 270 OHM 5% 1/2W	5-1271Z
R115		RES CF 270 OHM 5% 1/2W	5-1271Z
R116		RES CF 51K 5% 1/2W	5-1513Z
R117		RES CF 270 OHM 5% 1/2W	5-1271Z
R121		RES CF 560 OHM 5% 1/2W	5-1561Z
R122		RES CF 3.9K 5% 1/4W	5-1392
R123		RES CF 3.9K 5% 1/4W	5-1392
R124		RES CF 3.9K 5% 1/4W	5-1392
R125		RES CF 91 OHM 5% 1/4W	5-1910
R126		RES CF 91 OHM 5% 1/4W	5-1910
R127		RES CF 91 OHM 5% 1/4W	5-1910
SG01		SPARK GAP 200V 20%	5-0111
SG02		SPARK GAP 200V 20%	5-0111
SG03		SPARK GAP 200V 20%	5-0111
SG04		SPARK GAP 200V 20%	5-0111
VR101		VAR-RES VG084TH1-B20K SVR	5-8021S
VR102		VAR-RES VG084TH1-B20K SVR	5-8021S
VR103		VAR-RES VG084TH1-B20K SVR	5-8021S
W101		4P BASE MINI (UL)	5-0503W
W102		2P BASE MINI (UL)	5-0102W
W103		6P SOCKET MICRO	5-0103W
ZD101		DIODE HZ7C2 7.5V 2% 1/2 W	5-3272

MAIN BOARD

REF #		PART DESCRIPTION	ITEM #
C401		CAP CPN 0.1UF 50V 5%	5-2103BX
C402		CAP CC 1000PF 50V 20% Y5P	5-2106YZ
C403		CAP EC 10UF 50V 20%	5-2101BZ
C404		CAP CC 1000PF 50V 20% Y5P	5-2106YZ
C405		CAP CPN 0.15UF 50V 5%	5-2153BX
C406		CAP CC 1000PF 50V 20% Y5P	5-2106YZ
C407		CAP CC 1000PF 50V 20% Y5P	5-2106YZ
C408		CAP CPN 0.0047UF 50V 5%	5-2475BX
C409		CAP EC 330UF 25V 20%	5-2330AZ
C410		CAP CET 2.2UF 25V 20%	5-2222AZ
C411		CAP CC 220PF 50V 20% Y5P	5-2227BZ

C412		CAP CC 220PF 50V 20% Y5P	5-2227BZ	
C413		CAP EC 1UF 50V 20%	5-2102BZ	
C414		CAP EC 33UF 50V 20%	5-2331BZ	
C415		CAP EC 4700UF 25V 20%	5-2470ZZ	
C416		CAP CNP 100UF 25V 20%	5-2100NZ	
C417		CAP EC 220UF 25V 20%	5-2220AZ	
C418		CAP CC 680PF 50V 20% Y5P	5-2687BZ	
C419		CAP EC 1UF 50V 20%	5-2102BZ	
C421		CAP EC 33UF 50V 20%	5-2331BZ	
C422		CAP EC 33UF 50V 20%	5-2331BZ	
C423		CAP CC 1000PF 50V 20% Y5P	5-2106YZ	
C424		CAP EC 470UF 25V 20%	5-2470AZ	
C425		CAP EC 1UF 50V 20%	5-2102BZ	
C426		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C428		CAP EC 220UF 25V 20%	5-2220AZ	
C430		CAP EC 220UF 25V 20%	5-2220AZ	
C431		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C432		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C433		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C435		CAP CME 0.1UF 250V 5%	5-2103EX	
C436		CAP EC 1UF 50V 20%	5-2102BZ	
C437		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C438		CAP CC 0.01UF 50V 20% Y5P	5-2104BZ	
C439		CAP CC 680PF 50V 20% Y5P	5-2687BZ	
C440		CAP CC 680PF 50V 20% Y5P	5-2687BZ	
C441		CAP EC 470UF 25V 20%	5-2470AZ	
C442		CAP EC 10UF 50V 20%	5-2101BZ	
C501		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C503		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C504		CAP EC 47UF 160V 20%	5-2471DZ	
C505		CAP CC 0.01UF 500V 20% Z5U	5-2104FZ	
C506		CAP EC 100UF 160V 20%	5-2100DZ	
C507		CAP CC 0.01UF 500V 20% Z5U	5-2104FZ	
C509		CAP EC 1000UF 25V 20%	5-2100ZZ	
C510		CAP CPN 0.022UF 50V 5%	5-2224BX	
C511		CAP EC 10UF 100V 20%	5-2102CZ	
C512	⚠	CAP PP 0.0068UF 1.6KV 5%	5-2686IX	
C513	⚠12	CAP PP 0.022UF 630V 5%	5-2223GX	
C513	⚠14	CAP PP 0.018UF 630V 5%	5-2184GX	
C513	⚠16	CAP PP 0.022UF 630V 5%	5-2223GX	
C514		CAP EC 100UF 25V 20%	5-2100AZ	
C515		CAP CC 180PF 500V 20% Y5P	5-2187FZ	
C516		CAP CC 1000PF 50V 20% Y5P	5-2106YZ	
C517		CAP EC 10UF 50V 20%	5-2101BZ	
C519		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C520		CAP CMT 1000PF 50V 10% NPO	5-2106BY	
C521		CAP CET 1UF 25V 10%	5-2102AY	
C522		CAP EC 1UF 50V 20%	5-2102BZ	
C523		CAP EC 47UF 25V 20%	5-2471AZ	
C524		CAP CMT 1000PF 50V 10% NPO	5-2106BY	
C525	⚠	CAP PP 0.33UF 250V 5%	5-2333EX	
C526	⚠12	CAP PP 0.47UF 250V 5%	5-2473EX	
C526	⚠14	CAP PP 0.47UF 250V 5%	5-2473EX	
C526	⚠16	CAP PP 0.68UF 250V 5%	5-2683EX	
C527	⚠12	CAP PP 0.47UF 250V 5%	5-2473EX	
C527	⚠14	CAP PP 0.47UF 250V 5%	5-2473EX	
C527	⚠16	CAP PP 0.82UF 250V 5%	5-2823EX	
C528	⚠	CAP PP 0.82UF 250V 5%	5-2823EX	
C529		CAP EC 470UF 25V 20%	5-2470AZ	
C530		CAP CPN 0.0047UF 50V 5%	5-2475BX	
C531		CAP EC 1UF 50V 20%	5-2102BZ	

C532		CAP CPN 0.015UF 50V 5%	5-2154BX	
C533		CAP CMT 1000PF 50V 10% NPO	5-2106BY	
C534		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C535		CAP CMT 1000PF 50V 10% NPO	5-2106BY	
C537		CAP CC 0.01UF 50V 20% Y5P	5-2104BZ	
C539		CAP CPN 0.01UF 50V 5%	5-2104BX	
C540		CAP CPN 0.22UF 50V 5%	5-2223BX	
C541	*	CAP EC 4.7UF 100V 20%	5-2472CZ	
C542		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C543		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C544		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C545		CAP EC 47UF 16V 20%	5-2471JZ	
C548		CAP CPN 0.0047UF 50V 5%	5-2475BX	
C549		CAP CPN 0.033UF 50V 5%	5-2334BX	
C550		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C551		CAP EC 1UF 50V 20%	5-2102BZ	
C553		CAP CC 1000PF 50V 20% Y5P	5-2106YZ	
C554		CAP CC 0.01UF 5OV 20% Y5P	5-2104BZ	
C555		CAP CC 0.01UF 5OV 20% Y5P	5-2104BZ	
C556		CAP CC 0.01UF 5OV 20% Y5P	5-2104BZ	
C557		CAP CC 120PF 50V 20% Y5P	5-2127BZ	
C559		CAP CPN 0.1UF 50V 5%	5-2103BX	
C560		CAP CPN 0.1UF 50V 5%	5-2103BX	
C561		CAP EC 330UF 25V 20%	5-2330AZ	
C562		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C565		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C566		CAP CC 220PF 50V 20% Y5P	5-2227BZ	
C567		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C568		CAP EC 10UF 50V 20%	5-2101BZ	
C569		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C570		CAP EC 10UF 50V 20%	5-2101BZ	
C571		CAP EC 47UF 16V 20%	5-2471JZ	
C573		CAP EC 10UF 50V 20%	5-2101BZ	
C574		CAP EC 10UF 50V 20%	5-2101BZ	
C601		CAP EC 2.2UF 250V 20%	5-2222EZ	
C603		CAP CME 0.1UF 250V 5%	5-2103EX	
C604		CAP EC 1UF 50V 20%	5-2102BZ	
C605		CAP EC 4.7UF 50V 20%	5-2472BZ	
C606		CAP CC 1000PF 50V 20% Y5P	5-2106YZ	
D401		DIODE 1N4148	5-3148	
D403		DIODE 1N4148	5-3148	
D404		DIODE 1N4148	5-3148	
D405		DIODE 1N4148	5-3148	
D406		DIODE 1N4148	5-3148	
D407		DIODE 1N4003	5-3003	
D408		DIODE 1N4148	5-3148	
D409		DIODE 1N4148	5-3148	
D410		DIODE 1N4148	5-3148	
D411		DIODE 11DQ06 60V 1A	5-3661	
D501		DIODE 15DF4 IR	5-3154	
D502		DIODE 1N4148	5-3148	
D503		DIODE 1N4003	5-3003	
D504		DIODE 1N4003	5-3003	
D506		DIODE 1N4148	5-3148	
D507		DIODE RECTIFIER 10DF2 IR	5-3102	
D508		DIODE RECTIFIER 10DF2 IR	5-3102	
D509		DIODE RECTIFIER 10DF2 IR	5-3102	
D510		DIODE SRP600K 6A	5-3600	
D511		DIODE SRP600K 6A	5-3600	
D512		DIODE 1N4148	5-3148	
D513		DIODE 1N4148	5-3148	
D514	*	DIODE RECTIFIER 10DF2 IR	5-3102	

D515		DIODE 1N4148	5-3148	
D516		DIODE 11DQ06 60V 1A IR	5-3661	
D517		DIODE 11DQ06 60V 1A IR	5-3661	
D601		DIODE RECTIFIER 10DF4 IR	5-3104	
D602		DIODE RECTIFIER 10DF2 IR	5-3102	
D603		DIODE 1N4148	5-3148	
D604		DIODE 1N4148	5-3148	
IC401		CHIP HA11235 18P	5-4235	
IC402		CHIP CA1458E OP-AMP 8P	5-4558	
IC404		CHIP CD4052 16P	5-4052	
IC405		CHIP CD4052 16P	5-4052	
IC406		CHIP REGULATOR UA7815C 3P	5-4815	
IC501		CHIP 74LS86 14P	5-4086	
IC502		CHIP 74LS221	5-4221	
IC504		CHIP UA339APC/LM339 14P	5-4339	
IC505		CHIP LM555 14P	5-4555	
IC506		CHIP CA1458E OP-AMP 8P	5-4558	
IC507		CHIP 74LS221	5-4221	
IC508		CHIP 74LS221	5-4221	
IC509		CHIP REGULATOR TL431CLP 3P	5-4431	
IC510		CHIP REGULATOR (+) UA7805C 3P	5-4805	
L501		COIL DRUM 5MH EE-35	5-5005	
L502		COIL DRUM CORE 2MH 300MA	5-5002	
L503		COIL H-LINEARTY 43UH-4UH	5-5434	
Q401		TRANS NPN 2SC945Q	5-6945	
Q402		TRANS PNP 2SB649AC POWER	5-6649	
Q403		TRANS NPN 2SC945Q	5-6945	
Q404		TRANS NPN 2SC945Q	5-6945	
Q405		TRANS NPN 2SD313 POWER	5-6313	
Q406		TRANS PNP 2SB507 POWER	5-6507	
Q407		TRANS PNP 2SB649AC POWER	5-6649	
Q408		TRANS NPN 2SC945Q	5-6945	
Q409		TRANS NPN 2SD1609C POWER	5-6609	
Q410		TRANS PNP 2SB649AC POWER	5-6649	
Q411		TRANS NPN 2SC945Q	5-6945	
Q413		TRANS NPN 2SC945Q	5-6945	
Q414		TRANS NPN 2SC945Q	5-6945	
Q501	*	TRANS NPN 2SD1163A POWER	5-6163	
Q502	*	TRANS PNP 2SB649AC POWER	5-6649	
Q503		TRANS IRF530 MOSFET POWER	5-6530	
Q504	*	TRANS NPN 2SD1556 OR 2SC3886A POWER	5-6886	
Q505		TRANS NPN TIP122 POWER	5-6122	
Q506		TRANS NPN TIP122 POWER	5-6122	
Q507		TRANS NPN TIP122 POWER	5-6122	
Q508		TRANS NPN 2SC945Q	5-6945	
Q509		TRANS IRF830 MOSFET POWER	5-6830	
Q510	*	TRANS IRF830 MOSFET POWER	5-6830	
Q511		TRANS PNP 2SB649AC POWER	5-6649	
Q512		TRANS NPN 2SC945Q	5-6945	
Q513		TRANS NPN 2SC945Q	5-6945	
Q514		TRANS NPN 2SC945Q	5-6945	
Q515		TRANS NPN 2SC945Q	5-6945	
Q516		TRANS PNP 2SA733P	5-6733	
Q517		TRANS NPN 2SC945Q	5-6945	
Q518		TRANS NPN 2SC945Q	5-6945	
Q601		TRANS NPN 2SC945Q	5-6945	
Q602		TRANS NPN 2SC945Q	5-6945	
R401		RES CF 470 OHM 5% 1/4W	5-1471	
R402		RES CF 470 OHM 5% 1/4W	5-1471	
R403		RES CF 1K 5% 1/4W	5-1102	
R404		RES MF 68K 1% 1/4W	5-1683F	

R405		RES CF 3.3K 5% 1/4W	5-1332	
R406		RES CF 6.8K 5% 1/4W	5-1682	
R407		RES CF 10K 5% 1/4W	5-1103	
R408		RES CF 330 OHM 5% 1/2W	5-1331Z	
R409		RES CF 39K 5% 1/4W	5-1393	
R410		RES CF 150K 5% 1/4W	5-1154	
R411		RES CF 62K 5% 1/4W	5-1623	
R412		RES CF 8.2K 5% 1/4W	5-1822	
R414		RES CF 330 OHM 5% 1/4W	5-1331	
R415	12	RES CF 270 OHM 5% 1/4W	5-1271	
R415	14	RES CF 240 OHM 5% 1/4W	5-1241	
R415	16	RES CF 270 OHM 5% 1/4W	5-1271	
R416		RES CF 10 OHM 5% 1/4W	5-1100	
R417		RES CF 220 OHM 5% 1/2W	5-1221Z	
R418		RES CF 56 OHM 5% 1/4W	5-1560	
R419		RES CF 1 OHM 5% 1/2W	5-1010Z	
R420		RES CF 1K 5% 1/4W	5-1102	
R421		RES CF 4.7K 5% 1/4W	5-1472	
R422		RES CF 150 OHM 5% 1/2W	5-1151Z	
R423		RES CF 100 OHM 5% 1/4W	5-1101	
R424		RES CF 560 OHM 5% 1/2W	5-1561Z	
R425		RES CF 82 OHM 5% 1/2W	5-1820Z	
R426		RES CF 510 OHM 5% 1/4W	5-1511	
R427		RES CF 510 OHM 5% 1/4W	5-1511	
R428		RES CF 10 OHM 5% 1/4W	5-1100	
R430		RES CF 24K 5% 1/4W	5-1243	
R431		RES CF 240K 5% 1/4W	5-1244	
R432		RES CF 4.3K 5% 1/4W	5-1432	
R433		RES CF 4.3K 5% 1/4W	5-1432	
R434		RES CF 560 OHM 5% 1/4W	5-1561	
R435		RES CF 100 OHM 5% 1/4W	5-1101	
R436	12	RES CF 270 OHM 5% 1/4W	5-1271	
R436	14	RES CF 270 OHM 5% 1/4W	5-1271	
R436	16	RES CF 220 OHM 5% 1/4W	5-1221	
R437		RES CF 5.6K 5% 1/4W	5-1562	
R438		RES CF 5.6K 5% 1/4W	5-1562	
R439		RES MO 1.5 OHM 5% 1W	5-1015M	
R439	12&	RES MO 2 OHM 5% 1W	5-1020M	
R440		RES CF 6.2K 5% 1/4W	5-1622	
R441		RES CF 220 OHM 5% 1/4W	5-1221	
R442		RES CF 12K 5% 1/4W	5-1123	
R443		RES CF 1.5K 5% 1/4W	5-1152	
R444		RES CF 6.2K 5% 1/4W	5-1622	
R445		RES CF 1.5K 5% 1/4W	5-1152	
R446		RES CF 1.2K 5% 1/4W	5-1122	
R447		RES CF 1K 5% 1/4W	5-1102	
R448		RES CF 4.3K 5% 1/4W	5-1432	
R449		RES CF 750 OHM 5% 1/4W	5-1751	
R453		RES CF 3.3K 5% 1/4W	5-1332	
R454		RES CF 3.3K 5% 1/4W	5-1332	
R455		RES CF 3.3K 5% 1/4W	5-1332	
R456		RES CF 1.8K 5% 1/4W	5-1182	
R457		RES CF 1M 5% 1/4W	5-1105	
R458	12	RES CF 270 OHM 5% 1/4W	5-1271	
R458	14	RES CF 240 OHM 5% 1/4W	5-1241	
R458	16	RES CF 270 OHM 5% 1/4W	5-1271	
R502		RES CF 150 OHM 5% 1/2W	5-1151Z	
R503		RES MO 8.2K 5% 2W 20MM	5-1882M	
R504		RES CF 1K 5% 1/4W	5-1102	
R505		RES MO 10 OHM 5% 2W 20 MM	5-1100M	
R506		RES CF 150 OHM 5% 1/2W	5-1151Z	

R508		RES CF 4.7K 5% 1/4W	5-1472	
R509	12	RES MO 2 OHM 5% 2W 20MM	5-1020M	
R509	14	RES MO 2 OHM 5% 2W 20MM	5-1020M	
R509	16	RES MO 0.5 OHM 5% 2W 20MM	5-1005M	
R510		RES MO 0.5 OHM 5% 2W 20MM	5-1005M	
R511	12	RES MO 270 OHM 5% 1W	5-1271M	
R511	14	RES MO 270 OHM 5% 1W	5-1271M	
R511	16	RES CF 560 OHM 5% 1/2W	5-1561M	
R512		RES CF 470 OHM 5% 1/4W	5-1471	
R513		RES CF 3.3K 5% 1/4W	5-1332	
R514		RES CF 30K 5% 1/4W	5-1303	
R515		RES CF 1K 5% 1/2W	5-1102Z	
R516		RES CF 680 OHM 5% 1/4W	5-1681	
R517		RES MF 12K 1% 1/4W	5-1123F	
R518		RES CF 3.3K 5% 1/4W	5-1332	
R519		RES CF 51K 5% 1/4W	5-1513	
R520		RES CF 68K 5% 1/4W	5-1683	
R521		RES CF 10K 5% 1/4W	5-1103	
R522		RES CF 2K 5% 1/4W	5-1202	
R523		RES CF 1.5K 5% 1/4W	5-1152	
R524		RES CF 51K 5% 1/4W	5-1513	
R525		RES MO 3.9K 5% 3W MINI	5-1392M	
R526		RES CF 2K 5% 1/4W	5-1202	
R527		RES MF 30K 1% 1/4W	5-1303F	
R528		RES CF 3.3K 5% 1/4W	5-1332	
R529		RES CF 1K 5% 1/4W	5-1102	
R530		RES MF 12K 1% 1/4W	5-1123F	
R531		RES MF 680 OHM 1% 1/4W	5-1681F	
R532		RES MF 1.2K 1% 1/4W	5-1122F	
R533		RES MF 2.7K 1% 1/4W	5-1272F	
R534		RES CF 240K 5% 1/4W	5-1244	
R535		RES CF 240K 5% 1/4W	5-1244	
R536		RES CF 240K 5% 1/4W	5-1244	
R537		RES CF 1K 5% 1/4W	5-1102	
R538		RES CF 6.2K 5% 1/4W	5-1622	
R539		RES CF 2K 5% 1/4W	5-1202	
R540		RES CF 2K 5% 1/4W	5-1202	
R541		RES CF 2K 5% 1/4W	5-1202	
R542		RES CF 2K 5% 1/4W	5-1202	
R543		RES CF 1K 5% 1/4W	5-1102	
R544		RES CF 1K 5% 1/4W	5-1102	
R545		RES CF 1K 5% 1/4W	5-1102	
R546		RES CF 100 OHM 5% 1/4W	5-1101	
R547		RES CF 100 OHM 5% 1/2W	5-1101Z	
R548		RES CF 22K 5% 1/4W	5-1223	
R549		RES CF 4.7K 5% 1/4W	5-1472	
R550		RES CF 1K 5% 1/4W	5-1102	
R551		RES CF 470 OHM 5% 1/2W	5-1471Z	
R552		RES MF 13K 1% 1/4W	5-1133F	
R553		RES CF 27K 5% 1/4W	5-1273	
R554		RES CF 1K 5% 1/4W	5-1102	
R555		RES CF 1K 5% 1/4W	5-1102	
R556		RES CF 4.3K 5% 1/4W	5-1432	
R557		RES CF 4.3K 5% 1/4W	5-1432	
R558		RES CF 15 OHM 5% 1/2W	5-1150Z	
R559		RES CF 240K 5% 1/4W	5-1244	
R560		RES CF 68K 5% 1/4W	5-1683	
R561	*	RES CF 10K 5% 1/4W	5-1103	
R562		RES CF 1K 5% 1/4W	5-1102	
R563		RES CF 1.5K 5% 1/4W	5-1152	
R564		RES CF 10K 5% 1/4W	5-1103	

R565		RES CF 1K 5% 1/4W	5-1102	
R566		RES CF 2K 5% 1/4W	5-1202	
R567		RES CF 2K 5% 1/4W	5-1202	
R568		RES CF 1K 5% 1/4W	5-1102	
R569		RES CF 2K 5% 1/4W	5-1202	
R570		RES CF 1K 5% 1/4W	5-1102	
R571		RES CF 1K 5% 1/4W	5-1102	
R572		RES CF 1K 5% 1/4W	5-1102	
R573		RES CF 1K 5% 1/4W	5-1102	
R574		RES CF 2OOK 5% 1/4W	5-1204	
R575		RES CF 150 OHM 5% 1/2W	5-1151Z	
R576		RES CF 100K 5% 1/4W	5-1104	
R577	*	RES CF 150K 5% 1/4W	5-1154	
R578	*	RES CF 5.1K 5% 1/4W	5-1512	
R579		RES CF 1K 5% 1/4W	5-1102	
R580		RES CF 0.5 OHM 5% 1/2W	5-1005Z	
R581		RES MO 2 OHM 5% 2W 20MM	5-1020M	
R582	14	RES CF 1M 5% 1/2W	5-1105Z	
R582	16	RES CF 1M 5% 1/2W	5-1105Z	
R583	14	RES CF 1M 5% 1/2W	5-1105Z	
R583	16	RES CF 1M 5% 1/2W	5-1105Z	
R584		JUMPER WIRE		
R585		JUMPER WIRE		
R586	14	RES CF 1M 5% 1/2W	5-1105Z	
R586	16	RES CF 1M 5% 1/2W	5-1105Z	
R587	14	RES CF 1M 5% 1/2W	5-1105Z	
R587	16	RES CF 1M 5% 1/2W	5-1105Z	
R588		RES CF 10K 5% 1/4W	5-1103	
R589		RES CF 1.8K 5% 1/4W	5-1182	
R590		RES CF 1K 5% 1/4W	5-1102	
R591		RES CF 1K 5% 1/4W	5-1102	
R592		RES CF 2.2 OHM 5% 1/2W	5-1022Z	
R593		RES CF 7.5K 5% 1/4W	5-1752	
R594		RES CF 680 OHM 5% 1/4W	5-1681	
R601		RES CF 1.2K 5% 1/4W	5-1122	
R602		RES CF 100K 5% 1/4W	5-1104	
R603	12	RES CF 100K 5% 1/4W	5-1104	
R603	14	RES CF 100K 5% 1/4W	5-1104	
R603	16	RES CF 75K 5% 1/4W	5-1753	
R604	12	RES CF 2OOK 5% 1/4W	5-1204	
R604	14	RES CF 2OOK 5% 1/4W	5-1204	
R604	16	RES CF 100K 5% 1/4W	5-1104	
R605		RES CF 51K 5% 1/2W	5-1513Z	
R606		RES CF 330K 5% 1/4W	5-1334	
R607		RES CF 10K 5% 1/4W	5-1103	
T501		X-FORMER H-DRIVE	5-7200	
T502	*	FBT HFT814A OR 2435552	5-7552	
T502	* 12&	FBT HFT846	5-7846	
T503		X-FORMER PINCUSHION	5-7100	
T504		X-FORMER PINCUSHION	5-7100	
TP401		2.36MM R PIN	5-0101P	
VR401		VAR-RES 5K-B 8MM	5-8005	
VR402		VAR-RES 20K-B 8MM SVR	5-8020S	
VR407		VAR-RES 1K-B 8MM SVR	5-8001	
VR408		VAR-RES 100-B 8MM	5-8010	
VR501		VAR-RES B500 19MM SVR	5-8305	
VR502		VAR-RES 5K-B 8MM	5-8005	
VR505		VAR-RES 10K-B 8MM	5-8011S	
VR506		VAR-RES 10K-B 8MM	5-8011S	
VR507		VAR-RES 20K-B 8MM SVR	5-8020S	
VR602	*	VAR-RES 10K-B 8MM	5-8011S	

W401		SOCKET 3P MICRO	5-0300W
W402		SOCKET 3P MICRO	5-0300W
W501		SOCKET 6P BASE	5-0303W
W502		SOCKET 3P MICRO	5-0300W
W503		4P BASE MINI (UL)	5-0503W
W504		4P BASE MINI (UL)	5-0503W
W505		6P BASE 7.5MM	5-0505W
W506		SOCKET 5P MICRO	5-0500W
W507		SOCKET 3P MICRO	5-0300W
W508		SOCKET 5P MICRO	5-0500W
W509		SOCKET 6P MICRO	5-0103W
W601		SOCKET 3P MICRO	5-0300W
ZD401		DIODE ZENER HZ12A2 12V	5-3122
ZD501		DIODE ZENER HZ202 1/2W 2% ZD20V	5-3202
ZD502	*	DIODE ZENER HZ302 1/2W 2% ZD30V	5-3302
ZD504		DIODE ZENER HZ5B2 1/2W 2% ZD5.1V	5-3052
ZD601		DIODE ZENER RD100EB 1/2W 100V	5-3100
ZD602		DIODE ZENER RD6.8EB2	5-3682

VIDEO BOARD

T3 DENOTES COMPONENTS USED ON REV 1 TO 3 BOARDS ONLY
T4 DENOTES COMPONENTS USED ON REV 4 BOARDS ONLY

REF #		PART DESCRIPTION	ITEM #
C201		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C202		CAP EC 47UF 25V 20%	5-2471AZ
C203	T4	CAP EC 100UF 25V 20%	5-2100AZ
C204	T4	CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C205	T4	CAP EC 10UF 50V 20%	5-2101BZ
C206		CAP EC 100UF 25V 20%	5-2100AZ
C207		CAP EC 100UF 25V 20%	5-2100AZ
C208		CAP EC 100UF 25V 20%	5-2100AZ
C209		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C210		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C211		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C215		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C216		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C217		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C218	T4	CAP EC 10UF 50V 20%	5-2101BZ
C221		CAP EC 100UF 25V 20%	5-2100AZ
C222		CAP EC 100UF 25V 20%	5-2100AZ
C223		CAP EC 100UF 25V 20%	5-2100AZ
C224		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C225		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C226		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C227		CAP CC 82PF 50V 10% NPO	5-2828BY
C228		CAP CC 82PF 50V 10% NPO	5-2828BY
C229		CAP CC 22PF 50V 10% NPO	5-2228BY
C230		CAP EC 220UF 25V 20%	5-2220AZ
C231	T3	CAP EC 10UF 50V 20%	5-2101BZ
C231	T4	CAP EC 0.1UF 50V 20%	5-2013BZ
C232		CAP EC 1UF 50V 20%	5-2102BZ
C233		CAP EC 10UF 50V 20%	5-2101BZ
C234	T3	CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C234	T4	CAP CMT 1UF 50V 20% Z5U	5-2012BZ
C235	T3	CAP EC 22UF 25V 20%	5-2221AZ
C235	T4	CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ
C236		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ

C237		CAP CMT 0.22UF 50V 20% Z5U	5-2223BZ	
C238		CAP CMT 0.22UF 50V 20% Z5U	5-2223BZ	
C239		CAP CMT 0.22UF 50V 20% Z5U	5-2223BZ	
C240		CAP EC 10UF 50V 20%	5-2101BZ	
C241		CAP EC 10UF 50V 20%	5-2101BZ	
C242		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C243		CAP EC 100UF 25V 20%	5-2100AZ	
C245		CAP EC 10UF 50V 20%	5-2101BZ	
C246		CAP EC 100UF 35V 20%	5-2100LZ	
C247		CAP EC 100UF 25V 20%	5-2100AZ	
C248		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C249		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C250		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C251		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C252		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C253		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C254		CAP EC 22UF 25V 20%	5-2221AZ	
C258		CAP CMT 0.1UF 50V 20% Z5U	5-2103BZ	
C259		CAP EC 10UF 50V 20%	5-2101BZ	
C260		CAP CC 1000PF 50V 20% Y5P	5-2106BZ	
C261	T4	CAP CC 1000PF 50V 20% Y5P	5-2106BZ	
C263		CAP CC 27PF 50V 10% NPO	5-2278BY	
D201		DIODE 1N4148	5-3148	
D202		DIODE 1N4148	5-3148	
D203		DIODE 1N4148	5-3148	
D204		DIODE 1N4148	5-3148	
D205		DIODE 1N4148	5-3148	
D206		DIODE 1N4148	5-3148	
D207		DIODE 1N4148	5-3148	
D208		DIODE 1N4148	5-3148	
D209		DIODE 1N4148	5-3148	
D210		DIODE 1N4148	5-3148	
D211		DIODE 1N4148	5-3148	
D212		DIODE 1N4148	5-3148	
D216		DIODE 1N4148	5-3148	
D217		DIODE 1N4148	5-3148	
D218		DIODE 1N4148	5-3148	
D219		DIODE 1N4148	5-3148	
D220		DIODE 1N4148	5-3148	
D221		DIODE 1N4148	5-3148	
D222		DIODE 1N4148	5-3148	
D223		DIODE 1N4148	5-3148	
D224		DIODE 1N4148	5-3148	
D225		DIODE 1N4148	5-3148	
D226		DIODE 1N4148	5-3148	
D227		DIODE 1N4148	5-3148	
D228		DIODE 1N4148	5-3148	
D229		DIODE 1N4148	5-3148	
D230		DIODE 1N4148	5-3148	
D231		DIODE 1N4148	5-3148	
D232		DIODE 1N4148	5-3148	
D233		DIODE 1N4148	5-3148	
D234		DIODE 1N4148	5-3148	
D235		DIODE 1N4148	5-3148	
D236		DIODE 1N4148	5-3148	
D237	T3	DIODE 1N4148	5-3148	
D237	T4	DIODE ARRAY 1N4148 X 6	5-3148A	
D238	T3	DIODE 1N4148	5-3148	
D238	T4	DIODE ARRAY 1N4148 X 6	5-3148A	
D239		DIODE 1N4148	5-3148	
D240		DIODE 1N4148	5-3148	

D241		DIODE 1N4148	5-3148	
D242		DIODE 1N4148	5-3148	
D243	T3	DIODE 1N4148	5-3148	
D244	T3	DIODE 1N4148	5-3148	
IC201		CHIP 74S473 20P	5-4473	
IC202		CHIP 74LS393 14P	5-4393	
IC203		CHIP 74LS136 14P	5-4136	
IC204		CHIP 74S03 14P	5-4003	
IC205		CHIP 74S05 14P	5-4005	
IC206		CHIP 7406 14P	5-4406	
IC207		CHIP 74S86 14P	5-4086	
IC208	T3	CHIP 556 14P	5-4556	
IC208	T4	CHIP LM 555 8P	5-4555	
IC209		CHIP REGULATOR UA7815C 3P	5-4815	
IC210		CHIP 7406 14P	5-4006	
Q201		TRANS NPN 2SC945Q	5-6945	
Q202		TRANS NPN 2SC945Q	5-6945	
Q203		TRANS NPN 2SC945Q	5-6945	
Q204		TRANS NPN 2SC945Q	5-6945	
Q205		TRANS NPN 2SC945Q	5-6945	
Q206		TRANS PNP 2SA733P	5-6733	
Q207		TRANS PNP 2N3906	5-6906	
Q208		TRANS PNP 2N3906	5-6906	
Q209		TRANS PNP 2N3906	5-6906	
Q210		TRANS NPN 2N3904	5-6904	
Q211		TRANS NPN 2N3904	5-6904	
Q212		TRANS NPN 2N3904	5-6904	
Q213		TRANS NPN 2N3904	5-6904	
Q214		TRANS NPN 2N3904	5-6904	
Q215		TRANS NPN 2N3904	5-6904	
Q216		TRANS FET MPF4392	5-6392	
Q217		TRANS FET MPF4392	5-6392	
Q218		TRANS FET MPF4392	5-6392	
Q219		TRANS PNP 2SA733P	5-6733	
Q220		TRANS NPN 2SC945Q	5-6945	
Q221	T4	TRANS NPN 2SC945Q	5-6945	
R201		RES MHR-6-471JA SIP	5-1009	
R202		RES MHR-6-471JA SIP	5-1009	
R203		RES MF 390 OHM 1% 1/4W	5-1391F	
R204		RES MF 390 OHM 1% 1/4W	5-1391F	
R205		RES MF 390 OHM 1% 1/4W	5-1391F	
R206	T3	RES MF 270 OHM 1% 1/4W	5-1271F	
R206	T4	RES MF 300 OHM 1% 1/4W	5-1301F	
R207	T3	RES MF 270 OHM 1% 1/4W	5-1271F	
R207	T4	RES MF 300 OHM 1% 1/4W	5-1301F	
R208	T3	RES MF 270 OHM 1% 1/4W	5-1271F	
R208	T4	RES MF 300 OHM 1% 1/4W	5-1301F	
R209		RES MF 270 OHM 1% 1/4W	5-1271F	
R210		RES MF 270 OHM 1% 1/4W	5-1271F	
R211		RES MF 270 OHM 1% 1/4W	5-1271F	
R212		RES CF 100 OHM 5% 1/4W	5-1101	
R213		RES CF 15K 5% 1/4W	5-1153	
R214		RES CF 15K 5% 1/4W	5-1153	
R215		RES CF 15K 5% 1/4W	5-1153	
R216		RES CF 51 OHM 5% 1/4W	5-1510	
R217		RES CF 51 OHM 5% 1/4W	5-1510	
R218		RES CF 51 OHM 5% 1/4W	5-1510	
R219		RES CF 2K 5% 1/4W	5-1202	
R220		RES CF 2K 5% 1/4W	5-1202	
R221		RES CF 2K 5% 1/4W	5-1202	
R222		RES CF 330 OHM 5% 1/4W	5-1331	

R223		RES CF 330 OHM 5% 1/4W	5-1331	
R224		RES CF 330 OHM 5% 1/4W	5-1331	
R225		RES CF 330 OHM 5% 1/4W	5-1331	
R226		RES CF 330 OHM 5% 1/4W	5-1331	
R227		RES CF 330 OHM 5% 1/4W	5-1331	
R228		RES CF 150 OHM 5% 1/4W	5-1151	
R229		RES CF 150 OHM 5% 1/4W	5-1151	
R230		RES CF 150 OHM 5% 1/4W	5-1151	
R231	12	RES CF 150 OHM 5% 1/4W	5-1151	
R231	14	JUMPER WIRE		
R231	16	JUMPER WIRE		
R232	12	RES CF 150 OHM 5% 1/4 W	5-1151	
R232	14	JUMPER WIRE		
R232	16	JUMPER WIRE		
R233	12	RES CF 150 OHM 5% 1/4 W	5-1151	
R233	14	JUMPER WIRE		
R233	16	JUMPER WIRE		
R234		RES CF 1K 5% 1/4 W	5-1102	
R235		RES CF 1K 5% 1/4 W	5-1102	
R236		RES CF 1K 5% 1/4 W	5-1102	
R237	12	RES CF 91 OHM 5% 1/4 W	5-1910	
R237	14	RES CF 68 OHM 5% 1/4 W	5-1680	
R237	16	RES CF 47 OHM 5% 1/4 W	5-1470	
R238	12	RES CF 91 OHM 5% 1/4 W	5-1910	
R238	14	RES CF 68 OHM 5% 1/4 W	5-1680	
R238	16	RES CF 47 OHM 5% 1/4 W	5-1470	
R239	12	RES CF 91 OHM 5% 1/4 W	5-1910	
R239	14	RES CF 68 OHM 5% 1/4 W	5-1680	
R239	16	RES CF 47 OHM 5% 1/4 W	5-1470	
R240		RES CF 1K 5% 1/4 W	5-1102	
R241		RES CF 1K 5% 1/4 W	5-1102	
R242		RES CF 1K 5% 1/4 W	5-1102	
R243		RES CF 470 OHM 5% 1/4 W	5-1471	
R244		RES CF 470 OHM 5% 1/4 W	5-1471	
R245		RES CF 330 OHM 5% 1/4 W	5-1331	
R246		RES CF 1K 5% 1/4 W	5-1102	
R247		RES CF 3.3K 5% 1/4 W	5-1332	
R248		RES CF 10K 5% 1/4 W	5-1103	
R249		RES CF 22K 5% 1/4 W	5-1223	
R250		RES CF 10 OHM 5% 1/4 W	5-1100	
R251		RES CF 10 OHM 5% 1/4 W	5-1100	
R252		RES CF 10 OHM 5% 1/4 W	5-1100	
R253		RES CF 100 OHM 5% 1/4 W	5-1101	
R254		RES CF 3.3K 5% 1/4 W	5-1332	
R255	T4	RES CF 2.2K 5% 1/4 W	5-1222	
R256		RES CF 470 OHM 5% 1/4 W	5-1471	
R257		RES CF 470 OHM 5% 1/4 W	5-1471	
R258		RES CF 470 OHM 5% 1/4 W	5-1471	
R259		RES CF 33 OHM 5% 1/4 W	5-1330	
R260		RES CF 33 OHM 5% 1/4 W	5-1330	
R261		RES CF 33 OHM 5% 1/4 W	5-1330	
R262		RES CF 470K 5% 1/4 W	5-1474	
R263		RES CF 470K 5% 1/4 W	5-1474	
R264		RES CF 470K 5% 1/4 W	5-1474	
R265		RES CF 120K 5% 1/4 W	5-1124	
R266		RES CF 120K 5% 1/4 W	5-1124	
R267		RES CF 120K 5% 1/4 W	5-1124	
R268		RES CF 3.3K 5% 1/4 W	5-1332	
R269		RES CF 470 OHM 5% 1/4 W	5-1471	
R270		RES CF 1K 5% 1/4 W	5-1102	
R271		RES CF 1K 5% 1/4 W	5-1102	

R272		RES CF 1K 5% 1/4 W	5-1102	
R273		RES CF 1K 5% 1/4 W	5-1102	
R274		RES CF 1K 5% 1/4 W	5-1102	
R275		RES CF 2K 5% 1/4 W	5-1202	
R276		RES CF 3.3K 5% 1/4 W	5-1332	
R277	T3	RES CF 1K 5% 1/4 W	5-1102	
R277	T4	RES CF 470 OHM 5% 1/4 W	5-1471	
R278		RES CF 1K 5% 1/4 W	5-1102	
R279		RES CF 470 OHM 5% 1/4 W	5-1102	
R280		RES CF 470 OHM 5% 1/4 W	5-1102	
R281		RES CF 3.3K 5% 1/4 W	5-1332	
R282		RES CF 51 OHM 5% 1/2 W	5-1510Z	
R283	T4	RES CF 1.2K 5% 1/4 W	5-1122	
R284		RES CF 1.5K 5% 1/4 W	5-1152	
R285		RES CF 51K 5% 1/4 W	5-1513	
R286		RES CF 4.3 OHM 5% 1/4 W	5-1043	
R287		RES CF 470 OHM 5% 1/4 W	5-1471	
R288		RES CF 100 OHM 5% 1/4 W	5-1101	
R289		RES CF 100 OHM 5% 1/4 W	5-1101	
R290		RES CF 820 OHM 5% 1/4 W	5-1821	
R291		RES CF 10K 5% 1/4 W	5-1103	
R292	12	JUMPER WIRE		
R292	14	RES CF 22 OHM 5% 1/4 W	5-1220	
R292	16	RES CF 22 OHM 5% 1/4 W	5-1220	
R293	12	JUMPER WIRE		
R293	14	RES CF 22 OHM 5% 1/4 W	5-1220	
R293	16	RES CF 22 OHM 5% 1/4 W	5-1220	
R294	12	JUMPER WIRE		
R294	14	RES CF 22 OHM 5% 1/4 W	5-1220	
R294	16	RES CF 22 OHM 5% 1/4 W	5-1220	
R295	T4	RES CF 1K 5% 1/4 W	5-1102	
R296	T4	RES CF 1 OHM 5% 1/4 W	5-1010	
R297	T4	RES CF 2.2K 5% 1/4 W	5-1222	
R298		RES CF 10K 5% 1/4W	5-1103	
R299	T4	RES CF 470 OHM 5% 1/4 W	5-1471	
R2A0	T4	RES CF 10 OHM 5% 1/4 W	5-1100	
R2A1	T4	RES CF 10 OHM 5% 1/4 W	5-1100	
R2A2	T4	RES CF 10 OHM 5% 1/4 W	5-1100	
R2A3	T4	RES CF 10 OHM 5% 1/4 W	5-1100	
R2A4	T4	RES CF 10 OHM 5% 1/4 W	5-1100	
R2A5	T4	RES CF 10 OHM 5% 1/4 W	5-1100	
R2A6	T4	RES CF 4.7 OHM 5% 1/4 W	5-1047	
R2A7	T4	RES CF 4.7 OHM 5% 1/4 W	5-1047	
R2A8	T4	RES CF 4.7 OHM 5% 1/4 W	5-1047	
R2A9	T4	RES CF 1K 5% 1/4 W	5-1102	
R2B0	T4	RES MF 110 OHM 1% 1/4 W	5-1111F	
R2B1	T4	RES MF 110 OHM 1% 1/4 W	5-1111F	
R2B2	T4	RES MF 110 OHM 1% 1/4 W	5-1111F	
SW204		SWITCH, SIGNAL, 30 PIN TTL/ANALOG	5-8530	
VR201	T3	VAR-RES 100 OHM SVR	5-8051S	
VR201	T4	VAR-RES 500 OHM SVR	5-8055S	
VR202	T3	VAR-RES 100 OHM SVR	5-8051S	
VR202	T4	VAR-RES 500 OHM SVR	5-8055S	
VR203	T3	VAR-RES 100 OHM SVR	5-8051S	
VR203	T4	VAR-RES 500 OHM SVR	5-8055S	
VR204		VAR-RES 20K-B 20% SVR	5-8020S	
VR205		VAR-RES 10K-B 20% SVR	5-8011S	
VR206		VAR-RES 10K-B 20% SVR	5-8011S	
VR207		VAR-RES 10K-B 20% SVR	5-8011S	
VR209		VAR-RES 10K-B 20% SVR	5-8011S	
W201		4P BASE MINI (UL)	5-0503W	

W202		2P BASE MINI (UL)	5-0102W	
W203		SOCKET 2P MICRO	5-0200W	
W204		SOCKET 2P MICRO	5-0200W	
W205		SOCKET 2P MICRO	5-0200W	
W206		D-SUB RIGHT ANGLE	5-0206W	
W207		SOCKET 3P MICRO	5-0300W	
W208		SOCKET 6P MICRO	5-0103W	
W209		SOCKET 10P MICRO	5-0110W	
W210		SOCKET 5P MICRO	5-0500W	
ZD201		ZENER DIODE HZ12A2 12V	5-3122	

POWER BOARD

REF #		PART DESCRIPTION	ITEM #	
BD301	⚠	DIODE BRIDGE 2KBP06 / 2KBP10	5-3610	
C301	⚠	CAP X 0.22UF 250V 20%	5-2223EZ	
C302	⚠	CAP X 0.22UF 250V 20%	5-2223EZ	
C303	⚠	CAP Y 4700PF 250V	5-2476E	
C304	⚠	CAP Y 4700PF 250V	5-2476E	
C305		CAP EC 330UF 200V	5-2330K	
C306		CAP EC 330UF 200V	5-2330K	
C307		CAP EC 100UF 35V 20%	5-2100LZ	
C308		CAP EC 100UF 35V 20%	5-2100LZ	
C309		CAP CC 0.01UF 1KV 20% Y5P	5-2104MZ	
C310		CAP CMT 6800PF 50V 10% NPO	5-2686BY	
C310	12&	CAP CMT 4700PF 50V 10% NPO	5-2476BY	
C311		CAP EC 2.2UF 100V 20%	5-2222CZ	
C312		CAP CC 1000PF 50V 20% Y5P	5-2106BZ	
C312	12&	CAP CC 470PF 50V 20% Y5P	5-2477BZ	
C313		CAP EC 100UF 35V 20%	5-2100LZ	
C314		CAP CC 0.01UF 50V 10%	5-2104BY	
C315		CAP EC 1UF 50V 20%	5-2102BZ	
C316		CAP CC 0.01UF 500V 10%	5-2104FZ	
C317		CAP CC 270PF 500V 10%	5-2277FY	
C318		CAP CC 270PF 500V 10%	5-2277FY	
C319		CAP CC 270PF 500V 10%	5-2277FY	
C320		CAP CC 270PF 500V 10%	5-2277FY	
C321		CAP EC 100UF 160V 20%	5-2100DZ	
C322		CAP EC 1000UF 35V 20%	5-2100ZL	
C323		CAP EC 100UF 35V 20%	5-2100LZ	
C324		CAP EC 470UF 16V 20% SFM	5-2470JZ	
C325		CAP EC 100UF 160V 20%	5-2100DZ	
C326		CAP EC 1000UF 35V 20%	5-2100ZL	
C327		CAP EC 100UF 35V 20%	5-2100LZ	
C328		CAP EC 470UF 16V 20%	5-2470JZ	
C330		CAP EC 100UF 100V 20%	5-2100CZ	
C331		CAP CC 470PF 1KV 10% Y5P	5-2477MY	
D301		DIODE RECTIFIER 10DF2 IR	5-3102	
D302		DIODE 1N4003	5-3003	
D303		DIODE RGP10M GI	5-3010	
D304		DIODE RECTIFIER 10DF2 IR	5-3102	
D305		DIODE RECTIFIER 10DF2 IR	5-3102	
D306		DIODE 30DF6	5-3306	
D307		DIODE 30DF2	5-3312	
D308		DIODE 15DF4 IR	5-3154	
D309		DIODE 30DF2	5-3312	
D310		DIODE RECTIFIER 10DF6 IR	5-3106	
D311		DIODE 15DF4 IR	5-3154	
F301	⚠	FUSE 2A 250V 5 x 20MM	5-0331	

IC301		CHIP TDA-4601 9P	5-4601
IC303		CHIP REGULATOR (+) UA7805C 3P	5-4805
L301		COIL BEAD CORD 0.45UH, 7A	5-5045
L302		COIL PEAKING 2.2UH 90MA 15%	5-5022
L303		COIL DRUM 60UH 550MA	5-5600
L304		COIL DRUM 60UH 550MA	5-5600
L305		COIL DRUM 60UH 550MA	5-5600
P301		2.36MM R PIN	5-0101P
Q302	⚠	TRANS NPN 2SC3460L POWER	5-6460
Q303		TRANS NPN 2SC1921 OR MPSW42	5-6042
R301		RES CF 100K 5% 1/2 W	5-1104Z
R302		RES CF 100K 5% 1/2 W	5-1104Z
R303		RES MO 1 OHM 5% 1W	5-1010M
R304		RES CF 100K 5% 1/4 W	5-1104
R305		RES CF 200K 5% 1/2 W	5-1204Z
R306		RES MO 5.1K 5% 3 W	5-1512M3
R307		RES MO 10K 5% 3W	5-1103M
R309		RES CF 27 OHM 5% 1/4 W	5-1270
R310		RES MO 27K 5% 3W	5-1273M
R312		RES MO 5.1K 5% 2W	5-1512M2
R313		RES CF 220 OHM 5% 1/4 W	5-1221
R314		RES CF 1.2K 5% 1/4 W	5-1122
R315		RES CF 18K 5% 1/4 W	5-1183
R316		RES CF 10K 5% 1/4 W	5-1103
R317		RES MO 100 OHM 5% 1W	5-1101M
R318		RES MO 15K 5% 2W	5-1153M
R319		RES CF 470 OHM 5% 1/4 W	5-1471
R320		RES MO 150 OHM 5% 2W	5-1151M
R321		RES CF 200K 5% 1/2 W	5-1204Z
T301		X-FORMER LINE FILTER EE-25 VER. 0	5-7300
T302	⚠	X-FORMER SWITCHING PWR TP6555C	5-7655
TH301	⚠	THERMISTOR 20 OHM 11A 30% POSISTOR	5-1020T
TH302	⚠	THERMISTOR 5D-11 5 OHM 2A	5-1005T
VR301	*	VAR-RES VG067TH1-B5K SVR	5-8205S
W301		3P BASE MINI (UL)	5-0501W
W302		4P BASE MINI (UL)	5-0503W
W303		SOCKET 6P BASE	5-0303W
W304		SOCKET 2P MICRO	5-0200W
W305		2P BASE MINI (UL)	5-0102W
ZD301		DIODE ZENER HZ13EB3 13V 0.5W 2%	5-3133

ULTRA-12 MISCELLANEOUS PARTS

REF #		PART DESCRIPTION	ITEM #
		FUSE HOLDER 751.0052	5-9009
		CRT SOCKET	5-9045
		MODEL LOGO	5-9201
		NAME PLATE	5-9005
		ULTRASYNC CARTON	5-9217
		ULTRASYNC OPERATORS MANUAL	5-9202
		WARRANTY CARD	5-9014
		POWER CORD BRAID SHIELD	5-9010
		CABLE D-SUB 25/9 PIN 1830 MM	5-9071
		CABLE D-SUB 25/15 PIN 1830 MM	5-9070
		SWIVEL BASE	5-9037
		SWIVEL BALL	5-9336
		DISH	5-9033
		INNER RING	5-9013
		OUTER RING	5-9030

		CRT 12" M29JNA00X50J	5-9289

ULTRA-12 REAR PLATE ASSEMBLY

REF #	PART DESCRIPTION	ITEM #
	REAR PLATE	5-9260
VR405	VAR-RES B500 V161CN20K-B500 V-SIZE	5-9080
VR406	VAR-RES V161CN20K-B5K V-POS	5-9081
VR503	VAR-RES V161CN20K-B5K H-SIZE	5-9082
VR504	VAR-RES V161CN20K-B50K H-POS	5-9083
SW201	SW SPPJ22NL01-PZ (16 / 64)	5-9086
SW203	SW SPPJ22NL01-PZ (OVER / UNDER)	5-9086
SW302	SW SWA033-4501 (VOLTAGE SELECT SWITCH	5-9087
	AC SOCKET/ LINE FILTER 03DEEG3HA/3EEB1	5-9078
	PUSH BUTTON, PLASTIC	5-9050

ULTRA-12 CHASSIS ASSEMBLY

REF #	PART DESCRIPTION	ITEM #
VR208	VAR-RES 1K-B 16MM CONTRAST	5-9084
VR601	VAR-RES 500K-B 16MM BRIGHTNESS	5-9085
	KNOB, PLASTIC (BRIGHTNESS, CONTRAST)	5-9051
	VAR-RES BRACKET	5-9380
LD301	LED GREEN LTL-233	5-9007
SW301	POWER SWITCH 2 PIN WK850A46	5-9008
SW202	TEXT SWITCH 2 PIN TL103A4	5-9088
	SWITCH HOLDER	5-9389
	DEGAUSSING COIL	5-9252

ULTRA-12 ASSEMBLIES

PART DESCRIPTION	ITEM #
ULTRA-12 POWER BOARD ASSEMBLY	5-9230
ULTRA-12 MAIN BOARD ASSEMBLY	5-9231
ULTRA-12 CRT BOARD ASSEMBLY	5-9232
ULTRA-12 VIDEO BOARD ASSEMBLY	5-9233
ULTRA-12 REAR PLATE SUB ASSY	5-9234
ULTRA-12 FRONT CABINET ASSY	5-9235
ULTRA-12 BACK CABINET ASSY	5-9236
ULTRA-12 CHASSIS ASSY	5-9237

ULTRA-14 MISCELLANEOUS PARTS

REF #	PART DESCRIPTION	ITEM #
	NAME PLATE	5-9005
	MODEL LOGO	5-9401
	WARRANTY CARD	5-9014
	ULTRA-14 OPERATORS MANUAL	5-9402
	ULTRA-14 CARTON	5-9417
	CABLE D-SUB 25/9 PIN 1830MM	5-9071
	CABLE D-SUB 25/15 PIN 1830MM	5-9070
	POWER CORD BRAID SHIELD	5-9010
	ULTRA-14 CRT M34KAM00X06	5-9489

		SWIVEL BASE	5-9037
		SWIVEL BALL	5-9336
		DISH	5-9033
		INNER RING	5-9031
		OUTER RING	5-9030
		FUSE HOLDER 751.0052	5-9045
		CRT SOCKET	5-9047

ULTRA-14 REAR PLATE ASSEMBLY

REF #		PART DESCRIPTION	ITEM #
		REAR PLATE	5-9460
VR405		VAR-RES B500 V161CN20K-B500 V-SIZE	5-9080
VR406		VAR-RES V161CN20K-B5K V-POS	5-9081
VR503		VAR-RES V161CN20K-B5K H-SIZE	5-9082
VR504		VAR-RES V161CN20K-B50K H-POS	5-9083
SW201		SW SPPJ22NL01-PZ (OVER / UNDER)	5-9086
SW203		SW SPPJ22NL01-PZ (16 / 64)	5-9086
SW302		SW SWA033-4501 (VOLTAGE SELECT SWITCH	5-9087
		AC SOCKET/ LINE FILTER 03DEEG3HA/3EEB1	5-9078
		PUSH BUTTON, PLASTIC	5-9050

ULTRA-14 CHASSIS ASSEMBLY

REF #		PART DESCRIPTION	ITEM #
VR208		VAR-RES 1K-B 16MM CONTRAST	5-9084
VR601		VAR-RES 500K-B 16MM BRIGHTNESS	5-9085
		KNOB, PLASTIC (BRIGHTNESS, CONTRAST)	5-9051
		VAR-RES BRACKET	5-9380
LD301		LED GREEN LTL-233	5-9007
SW301		POWER SWITCH 2 PIN WK850A46	5-9008
SW202		TEXT SWITCH 2 PIN TL103A4	5-9088
		SWITCH HOLDER	5-9389
		DEGAUSSING COIL	5-9452

ULTRA-14 ASSEMBLIES

		PART DESCRIPTION	ITEM #
		ULTRA-14 POWER BOARD ASSEMBLY	5-9430
		ULTRA-14 MAIN BOARD ASSEMBLY	5-9431
		ULTRA-14 CRT BOARD ASSEMBLY	5-9432
		ULTRA-14 VIDEO BOARD ASSEMBLY	5-9433
		ULTRA-14 REAR PLATE SUB ASSY	5-9434
		ULTRA-14 FRONT CABINET ASSEMBLY	5-9435
		ULTRA-14 BACK CABINET ASSEMBLY	5-9436
		ULTRA-14 CHASSIS ASSY	5-9437

ULTRA-16 MISCELLANEOUS PARTS

REF #		PART DESCRIPTION	ITEM #
		FUSE HOLDER 751.0052	5-9045
		CRT SOCKET	5-9047
		MODEL LOGO	5-9601

NAME PLATE	5-9005	
ULTRA-16 CARTON	5-9617	
ULTRA-16 OPERATORS MANUAL	5-9602	
WARRANTY CARD	5-9014	
POWER CORD BRAID SHIELD	5-9010	
CABLE D-SUB 25/9 PIN 1830 MM	5-9071	
CABLE D-SUB 25/15 PIN 1830 MM	5-9070	
SWIVEL BASE	5-9037	
SWIVEL BALL	5-9636	
DISH	5-9033	
INNER RING	5-9031	
OUTER RING	5-9030	
CRT 16" M38KCE81XE02	5-9689	

ULTRA-16 REAR PLATE ASSEMBLY

REF #	PART DESCRIPTION	ITEM #
	REAR PLATE	5-9660
VR405	VAR-RES B500 V161CN20K-B500 V-SIZE	5-9080
VR406	VAR-RES V161CN20K-B5K V-POS	5-9081
VR503	VAR-RES V161CN20K-B5K H-SIZE	5-9082
VR504	VAR-RES V161CN20K-B50K H-POS	5-9083
SW201	SW SPPJ22NL01-PZ (16 / 64)	5-9086
SW202	TEXT SWITCH 2 PIN TL103A4	5-9088
SW203	SW SPPJ22NL01-PZ (OVER / UNDER)	5-9086
SW302	SW SWA033-4501 (VOLTAGE SELECT SWITCH)	5-9087
	SWITCH HOLDER	5-9589
	AC SOCKET/ LINE FILTER 03DEEG3HA/3EEB1	5-9078
	PUSH BUTTON, PLASTIC	5-9050

ULTRA-16 CHASSIS ASSEMBLY

REF #	PART DESCRIPTION	ITEM #
VR208	VAR-RES 1K-B 16MM CONTRAST	5-9084
VR601	VAR-RES 500K-B 16MM BRIGHTNESS	5-9085
	KNOB, PLASTIC (BRIGHTNESS, CONTRAST)	5-9051
	VAR-RES BRACKET	5-9680
LD301	LED GREEN LTL-233	5-9007
SW301	POWER SWITCH 2 PIN WK850A46	5-9008
	DEGAUSSING COIL	5-9652

ULTRA-16 ASSEMBLIES

PART DESCRIPTION	ITEM #
ULTRA-16 POWER BOARD ASSEMBLY	5-9630
ULTRA-16 MAIN BOARD ASSEMBLY	5-9631
ULTRA-16 CRT BOARD ASSEMBLY	5-9632
ULTRA-16 VIDEO BOARD ASSSEMBLY	5-9633
ULTRA-16 REAR PLATE SUB ASSY	5-9634
ULTRA-16 FRONT CABINET ASSY	5-9635
ULTRA-16 BACK CABINET ASSY	5-9636
ULTRA-16 CHASSIS ASSY	5-9637